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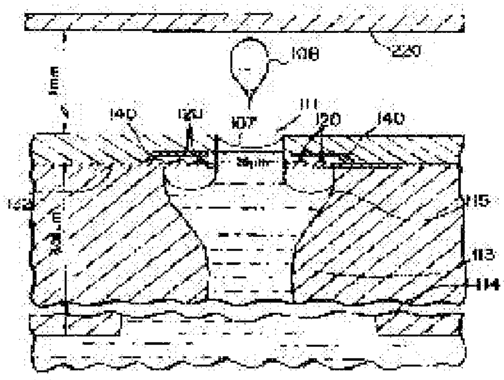
(54) **BUBBLE JET PRINTING DEVICE, PRODUCTION THEREOF AND BUBBLE JET PRINTING HEAD**



(57)Abstract:
PURPOSE: To facilitate the accurate alignment between two parts in a two-part structure by forming an ink supply passage, a nozzle and a heater means integrally.
CONSTITUTION: The passages 113, 114 piercing through the opposed surfaces of a semiconductor substrate 130 are formed by using semiconductor manufacturing technique and a part of them is formed into a nozzle for emitting an ink droplet 108 and an integrated BJ printing device having heater means 120 corresponding to the nozzle is constituted. Since this device is an one-part structure, there is no problem in the case of a two-part structure and the device is made long to easily provide a machinery corresponding to the whole width of recording paper.

CLAIMS

[Claim(s)]
[Claim 1]A bubble jet printing device characterized by coming to form said nozzle, said passage, and said heater means in one in a bubble jet printing device characterized by comprising the following.
Two or more nozzles.
A passage for being provided corresponding to each of a nozzle of this plurality, and it being open for free passage for the corresponding nozzle concerned, and supplying ink.
A heater means combined with each and said nozzle of said passage.

[Claim 2]The bubble jet printing device according to claim 1, wherein said nozzle, said passage, and said heater means are formed in one with a semiconductor material using semiconductor manufacturing technology.
[Claim 3]The bubble jet printing device according to claim 2, wherein said semiconductor material contains silicon.
[Claim 4]The bubble jet printing device according to claim 3, wherein said silicon is formed as a substrate which has the upper limit corresponding to the maximum print range in the move direction concerned of a print good Noh mask which carries out relative displacement to said device, and the crossing direction.
[Claim 5]The bubble jet printing device according to claim 4 which said print good Noh mask is a field of a record sheet, and is characterized by said upper limit being almost equal to width of said record sheet.
[Claim 6]The bubble jet printing device according to claim 5, wherein said record sheet is a thing of the A4 version and the upper limit of said substrate is 220 mm.
[Claim 7]The bubble jet printing device according to claim 5, wherein said record sheet is a thing of the A3 version and the upper limit of said substrate is 310 mm.
[Claim 8]The bubble jet printing device according to claim 2, wherein an electronic circuit combined with said device is formed in said device and one.
[Claim 9]The bubble jet printing device according to claim 8, wherein said electronic circuit contains an actuation device for being connected to said heater means and carrying out a simultaneous drive selectively.
[Claim 10]The bubble jet printing device according to claim 1, wherein each of said heater means has surrounded said corresponding passage or a nozzle.
[Claim 11]The bubble jet printing device according to claim 10, wherein said heater means has two heater elements which can be operated independent.
[Claim 12]The bubble jet printing device according to claim 11 only when one side of said two heater elements breaks down [another side], wherein it can operate.
[Claim 13]The bubble jet printing device according to claim 10, wherein said heater means is annular and said passage or said nozzle passes along an inside of the annular part concerned.
[Claim 14]The bubble jet printing device according to claim 10, wherein said heater means has surrounded said nozzle.
[Claim 15]The bubble jet printing device according to claim 10, wherein said heater means has surrounded a channel which has a portion of said passage which does not

contain said nozzle.
[Claim 16]The bubble jet printing device according to claim 1, wherein each of said nozzle and said passage has extended between opposed faces of a couple of said device.
[Claim 17]The bubble jet printing device according to claim 16 being open for free passage for a nozzle which said passage pierced through a semiconductor substrate, extended, and was positioned near the 1 surface of said substrate.
[Claim 18]said heater means -- said nozzle -- ****** -- having -- **** -- the bubble jet printing device according to claim 17 characterized by things.
[Claim 19]The bubble jet printing device according to claim 18, wherein said heater means has surrounded said nozzle.
[Claim 20]The bubble jet printing device according to claim 19, wherein said heater means is annular and said nozzle is positioned in an inside of the annular part concerned.
[Claim 21]The bubble jet printing device according to claim 20, wherein said passage has at least two portions from which a cross-section area differs.
[Claim 22]The bubble jet printing device according to claim 16, wherein said nozzle has a crevice on the whole surface of a semiconductor substrate and said passage extends between a field of an opposite hand of said substrate, and said crevice.
[Claim 23]The bubble jet printing device according to claim 22, wherein said passage has a thermal action room near the field of said opposite hand.
[Claim 24]The bubble jet printing device according to claim 23, wherein said heater means is allocated between said thermal action room and a field of said opposite hand.
[Claim 25]The bubble jet printing device according to claim 16 performing supply for two or more nozzles which have a heater means [each / of said passage] to which each corresponds.
[Claim 26]The bubble jet printing device according to claim 1 characterized by being shifted by column direction to a nozzle of one row or two rows which distance between a pair each of nozzles to which two or more line disposition of said nozzle is carried out, and which are adjoined on one row is almost equal, and a nozzle of each sequence adjoins.
[Claim 27]The bubble jet printing device according to claim 26, wherein a discrepancy of said column direction is [two] equal in about 1/of distance between nozzles in one row.
[Claim 28]The bubble jet printing device according to claim 26, wherein distance between adjoining nozzles on one row is almost equal to distance between adjacent pixels recorded on one row.
[Claim 29]The bubble jet printing device according to claim 28, wherein the number of said sequences is almost equal to a number of a dot of integral multiples which constitute each of a pixel in a direction which intersects perpendicularly with said sequence.
[Claim 30]The bubble jet printing device according to claim 29 making a driving state of said nozzle alternate.
[Claim 31]The bubble jet printing device according to claim 29, wherein it drove all the nozzles on one row almost simultaneous and they make a drive for every sequence alternate.
[Claim 32]The bubble jet print according to claim 26, wherein ink of a different color is supplied to a nozzle of a different sequence.
[Claim 33]The bubble jet printing device according to claim 1 provided with a heat-conduction part of one for transmitting heat to other portions of structure from a part of

structure of said device.
[Claim 34]The bubble jet printing device according to claim 33 connecting thermally other portions of said structure characterized by comprising the following.
Said heat-conduction part has a heat shunt, and is a high operating-temperature portion of said structure.
Comparatively high thermal conductivity.

[Claim 35]Said heat-conduction part has a thermal diffusion machine which has the 1st and 2nd portions in a heat transfer path, Said 1st portion connects a high operating-temperature portion of said structure to other portions thermally, said 2nd portion -- said -- others -- it being allocated by portion and having comparatively big surface area -- said -- others -- the bubble jet printing device according to claim 33, wherein a portion is what has a heat sink in a heat transfer path.
[Claim 36]The bubble jet printing device according to claim 34 or 35, wherein said heat-conduction part is the metal by which the stratification was carried out.
[Claim 37]The bubble jet printing device according to claim 36, wherein said metal is the aluminum by which vacuum deposition was carried out.
[Claim 38]The bubble jet printing device according to claim 35, wherein said heat sink has a supply source of bubble jet ink.
[Claim 39]The bubble jet printing device according to claim 1, wherein said heater means has two or more heaters which had an electronic drive circuit where each corresponds.
[Claim 40]The bubble jet printing device according to claim 39, wherein said exothermic means has surrounded a corresponding nozzle or a passage.
[Claim 41]The bubble jet printing device according to claim 40, wherein said heater means is almost annular.
[Claim 42]The bubble jet printing device according to claim 39, 40, or 41, wherein said heater means has two heaters.
[Claim 43]The bubble jet printing device according to claim 42, wherein each of said heater has meandering shape within a semicircular state outline.
[Claim 44]The bubble jet printing device according to claim 42 characterized by a thing for which each of said heater has a partial revolution part thru/or two or more revolution parts, and it is a plug-like if flat, and it is [a thing] complex with other heaters.
[Claim 45]The bubble jet printing device according to claim 42 connecting one electronic drive circuit of said two heaters to a drive circuit of other heaters, and being able to drive only when a heater besides the above is a malfunction.
[Claim 46]Bubble jet print DEIBASU according to claim 45, wherein it is provided on a semiconductor substrate and said two drive circuits are established in a position on said substrate not approaching.
[Claim 47]The bubble jet printing device according to claim 46, wherein said heater means is allocated between said two drive circuits.
[Claim 48]Each of said drive circuit has a solid state switch for a heater change, and this switch is an owner pole type thing, and in a terminal area of said one drive circuit and a drive circuit of another side. The bubble jet printing device according to claim 45 including a voltage level shifting means connected to a change input of said solid state switch of said one drive circuit.
[Claim 49]The bubble jet printing device according to claim 39, wherein said heater

means and said corresponding electronic drive circuit are arranged by a relation isolated mutually.
[Claim 50]The bubble jet printing device according to claim 49, wherein each of said heater means has two heaters which have said electronic drive circuit corresponding, respectively and said heater means is allocated between said drive circuits.
[Claim 51]The bubble jet printing device according to claim 50, wherein said heater means and said drive circuit are formed on a substrate at one and said drive circuit is allocated near the periphery of said substrate.
[Claim 52]The device comprising according to claim 1:
A nozzle of the 1st plurality and the 2nd plurality.
A heater means of the 1st same plurality and the 2nd plurality.

[Claim 53]By being combined with each means to perform said detection, and performing compensation corresponding to distance between said devices, The bubble jet printing device according to claim 52 having further a compensation means to which a print by a nozzle of other devices in a position corresponding to each nozzle of one device is permitted.
[Claim 54]It is the bubble jet picture reproducer which prints to a recording medium by carrying out the regurgitation of the ink droplet from the bubble jet printing device according to claim 1, Bubble jet picture reproducer in which the length of said printing device carries out that it is an equal mostly to a size of a direction which crosses towards relative displacement to said device of said recording medium with the feature.
[Claim 55]an electronic drive circuit for said device to enable a drive of each of said heater means according to a data input means to said device -- an owner -- the bubble jet picture reproducer according to claim 54 being a thing in the bottom.
[Claim 56]It has further a data timing circuit it is made to have data output performed for said nozzle in response to data input to said device, The bubble jet picture reproducer according to claim 55, wherein said data outputted is data in which a relative distance of a nozzle which differs in a color of a request pixel which should be printed, and a color is shown.
[Claim 57]The bubble jet picture reproducer according to claim 56, wherein said nozzle of said device prints a color chosen from a group which consists of cyanogen, magenta, yellow, and black.
[Claim 58]A bubble jet print head comprising:
The device according to claim 1.
An ink supply member for being able to unite with this device and supplying ink to said passage.
A filter means allocated between said device and said ink supply member in order to filter ink supplied to said device.

[Claim 59]The bubble jet print head according to claim 58, wherein said supply member has thermal conductivity and functions as a heat sink of said device.
[Claim 60]The bubble jet print head according to claim 58 or 59, wherein said supply member has electric insulation, and is further provided with an electric power supply connector which was connected to said device and attached to said supply member and said connector functions as a heat sink of said device.

[Claim 61]The bubble jet print head according to claim 58 or 59, wherein said filter means is pinched between said device and said supply member.
[Claim 62]The bubble jet print head according to claim 61, wherein said filter means has a film.
[Claim 63]It is a bubble jet print head which prints to a recording medium by carrying out the regurgitation of the ink droplet from the bubble jet printing device according to claim 1, In a size of a direction which crosses towards relative displacement to said device of said recording medium which should be recorded, while being an equal mostly, the length of said printing device, A bubble jet print head characterized for an electrical connection to said device by a thing of said device mostly formed covering the whole length.
[Claim 64]Color picture playback equipment, wherein ink of a color which said two or more nozzles are arranged as two or more sets, and is different for every set of said nozzle in color picture playback equipment provided with the bubble jet printing device according to claim 1 is supplied.
[Claim 65]The color picture playback equipment according to claim 64, wherein said set is arranged as an array which aligned with a constant interval.
[Claim 66]The color picture playback equipment according to claim 65, wherein ink of said color is chosen from a group which consists of cyanogen, magenta, yellow, and black.
[Claim 67]Picture element data of a picture supplied to said device is divided into two or more blocks, Each of this block has input data corresponding to said corresponding set on said bubble jet printing device while corresponding to said color, and said device, Have the 1st delay means established to each of said input data except for a thing to one set which performs ink discharge first, and each of this 1st delay means, The color picture playback equipment according to claim 66 characterized by delaying said each block according to distance between said one set and each set.
[Claim 68]While inside [respectively / said set] is arranged with regular intervals as for a nozzle, it is arranged as plural lines at equal intervals, A nozzle between contiguity sequences is shifted mutually and said device is further provided with a means to adjust data just before said data input, The color picture playback equipment according to claim 67 delaying data to a sequence within each block so that this adjustment device may have the 2nd delay means to each of said sequence and may compensate to a gap of a nozzle of said set.
[Claim 69]Each of said datcoord means has further the 3rd delay means that receives data from said 1st delay means, and outputs data to said 2nd delay means, The color picture playback equipment according to claim 68, wherein this 3rd delay means supplies a selectable delay cycle in relation to a specific set and supply is made by this set by it.
[Claim 70]In a datcoord machine which buffers picture element data to the bubble jet printing device according to claim 1, said two or more nozzles, Are an array of a sequence located in a line with a constant interval, and it is provided as an array which provided a gap to a nozzle of a contiguity sequence for every sequence, and arranged a nozzle with a constant interval, A datcoord machine by which said picture element data being delayed in order to provide the 1st delay means that performs predetermined delay to each of said sequence and to perform compensation according to a grade of a gap of said sequence.

[Claim 71]The datcoord machine according to claim 70, wherein a regurgitation order that said sequence was inserted by said each predetermined delay of said 1st delay means is defined.
[Claim 72]The datcoord machine according to claim 71, wherein it has further the 2nd delay means that outputs to each in advance of said 1st delay means and this 2nd delay means gives selectable delay to picture element data.
[Claim 73]A bubble jet printing device surrounding a passage or a nozzle characterized by comprising the following to which said heater means corresponds in a bubble jet printing device.
Two or more nozzles.
A passage for being provided corresponding to each of a nozzle of this plurality, and it being open for free passage for the corresponding nozzle concerned, and supplying ink.
A heater means combined with each and said nozzle of said passage.

[Claim 74]The bubble jet printing device according to claim 73, wherein said heater means has two heater elements which can be operated independent.
[Claim 75]The bubble jet printing device according to claim 74 only when one side of said two heater elements breaks down [another side], wherein it can operate.
[Claim 76]The bubble jet printing device according to claim 74, wherein said heater means is annular and said passage or said nozzle passes along an inside of the annular part concerned.
[Claim 77]The bubble jet printing device according to claim 74, wherein said heater means has surrounded said nozzle.
[Claim 78]The bubble jet printing device according to claim 74, wherein said heater means has surrounded a channel which has a portion of said passage which does not contain said nozzle.
[Claim 79]A bubble jet printing device which each of said nozzle and said passage extends between opposed faces of a couple of said device in a bubble jet storage device characterized by comprising the following, and is characterized by things.
Two or more nozzles.
A passage for being provided corresponding to each of a nozzle of this plurality, and it being open for free passage for the corresponding nozzle concerned, and supplying ink.
A heater means combined with each and said nozzle of said passage.

[Claim 80]The bubble jet printing device according to claim 79 being open for free passage for a nozzle which said passage pierced through a semiconductor substrate, extended, and was positioned near the 1 surface of said substrate.
[Claim 81]said heater means -- said nozzle -- ****** -- having -- **** -- the bubble jet printing device according to claim 80 characterized by things.
[Claim 82]The bubble jet printing device according to claim 81, wherein said heater means has surrounded said nozzle.
[Claim 83]The bubble jet printing device according to claim 82, wherein said heater means is annular and said nozzle is positioned in an inside of the annular part concerned.
[Claim 84]The bubble jet printing device according to claim 81, wherein said passage has at least two portions from which a cross-section area differs.
[Claim 85]The bubble jet printing device according to claim 79, wherein said nozzle has

a crevice on the whole surface of a semiconductor substrate and said passage extends between a field of an opposite hand of said substrate, and said crevice.
[Claim 86]The bubble jet printing device according to claim 85, wherein said passage has a thermal action room near the field of said opposite hand.
[Claim 87]The bubble jet printing device according to claim 86, wherein said heater means is allocated between said thermal action room and a field of said opposite hand.
[Claim 88]The bubble jet printing device according to claim 79 performing supply for two or more nozzles which have a heater means [each / of said passage] to which each corresponds.
[Claim 89]In a bubble jet printing device characterized by comprising the following, A bubble jet printing device characterized by being shifted by column direction to a nozzle of one row or two rows which distance between a pair each of nozzles to which two or more line disposition of said nozzle is carried out, and which are adjoined on one row is almost equal, and a nozzle of each sequence adjoins.
Two or more nozzles.
A passage for being provided corresponding to each of a nozzle of this plurality, and it being open for free passage for the corresponding nozzle concerned, and supplying ink.
A heater means combined with each and said nozzle of said passage.

[Claim 90]The bubble jet printing device according to claim 89, wherein a discrepancy of said column direction is [two] equal in about 1/of distance between nozzles in one row.
[Claim 91]The bubble jet printing device according to claim 89, wherein distance between adjoining nozzles on one row is almost equal to distance between adjacent pixels recorded on one row.
[Claim 92]The bubble jet printing device according to claim 91, wherein the number of said sequences is almost equal to a number of a dot of integral multiples which constitute each of a pixel in a direction which intersects perpendicularly with said sequence.
[Claim 93]The bubble jet printing device according to claim 92 making a driving state of said nozzle alternate.
[Claim 94]The bubble jet printing device according to claim 92, wherein it drove all the nozzles on one row almost simultaneous and they make a drive for every sequence alternate.
[Claim 95]The bubble jet print according to claim 89, wherein ink of a different color is supplied to a nozzle of a different sequence.
[Claim 96]In a method of manufacturing a bubble jet printing device from a semiconductor material using semiconductor manufacturing technology, A step which forms two or more passages which pass along a semiconductor substrate by (1) etching at least, And a heater means combined with said one passage which carries out (2) correspondences is deposited, A manufacturing method of a bubble jet printing device providing a step which manufactures heater drive electronic circuit structure combined with said exothermic means while being combined with said one corresponding passage, and performing said step (1) and (2) in arbitrary order.
[Claim 97]A manufacturing method of the bubble jet printing device according to claim 96, wherein said step (1) and (2) has two or more sub steps, respectively and a sub step of said step (1) is intermingled with a sub step of said step (2).
[Claim 98]A manufacturing method of the bubble jet printing device according to claim

96, wherein said step (1) contains a step which performs etching from both sides of said substrate.
[Claim 99]A manufacturing method of the bubble jet printing device according to claim 96, wherein said step (2) contains a step which forms simultaneously an electrical connection to said exothermic means and an element of said exothermic drive electronic circuit.
[Claim 100]A manufacturing method of the bubble jet printing device according to claim 96, wherein said step (1) or (2) performs this exposure gradually to an adjoining field it was made to expose one by one including a step which irradiates with electromagnetic waves of light or others.
[Claim 101]A manufacturing method of the bubble jet printing device according to claim 96 making it easy to etch said substrate along a dice or a score line of a schedule, and to divide said substrate into each printing device.
[Claim 102]Accumulation electronic circuit structure possessing an accumulation conductor which is the accumulation electronic circuit structure manufactured using semiconductor manufacturing technology, and it has in order to transmit heat to other portions from said a part of composition.
[Claim 103]An accumulated type conductor connecting thermally other portions of said structure characterized by comprising the following.
The accumulated type conductor according to claim 102 has a heat shunt, and is a high operating-temperature portion of said structure.
Comparatively high thermal conductivity.

[Claim 104]The accumulated type conductor according to claim 102 has a thermal diffusion way which has the 1st and 2nd portions in a heat transfer path, said 1st portion connects a high operating-temperature portion of said structure to other portions thermally -- said 2nd portion -- said -- others -- it being allocated by portion and having comparatively big surface area -- said -- others -- an accumulated type conductor, wherein a portion is what has a heat sink in a heat transfer path.
[Claim 105]The accumulated type conductor according to claim 103 or 104, wherein said conductor is the metal by which the stratification was carried out.
[Claim 106]The accumulated type conductor according to claim 105, wherein said metal is the aluminum by which vacuum deposition was carried out.
[Claim 107]The accumulated type conductor according to claim 106, wherein said accumulation electronic circuit structure is a bubble jet printing device and said high operating-temperature portion is a field on said device close to an exothermic means of said device.
[Claim 108]The accumulated type conductor according to claim 103, wherein said portion which has comparatively high thermal conductivity contains a semiconductor base substance.
[Claim 109]The accumulated type conductor according to claim 104, wherein said heat sink has a supply source of bubble jet ink.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]Especially this invention relates to a semiconductor bubble jet print head about ink jet printing art.
[0002]
[Description of the Prior Art]The bubble jet print head is known for this field, and, generally is used with a personal computer, and it is commercially available as a printer [that it is portable and comparatively low price] in it. There are a thing made from Hewlett Packard and BJ10 printer by Canon, Inc. as an example of this device.
[0003]Drawing 1 and drawing 2 are the outline perspective views showing the typical conventional bubble jet print head used by Canon, Inc. and Hewlett Packard, respectively.
[0004]The conventional bubble jet (BJ) head 1 is formed by BJ semiconductor chip device 2 which contacts the cap 3 by which laser etching was carried out so that drawing 1 may see. In this structure, the cap 3 is working as guidance for jet of the outwardness from the head 1 via two or more nozzles 5 for a for [inner] flow (an arrow shows among a figure) to the head 1 through the entrance 4 of ink.
[0005]The nozzle 5 is formed in the cap 3 as an end opening channel. On the BJ chip 2, one or more (usually 64) heater elements (un-illustrating) are arranged. If energy is given to a heater element, ink will be breathed out from each nozzle 5 with the air bubbles of the evaporation ink formed in the corresponding channel. the BJ chip 2 -- moreover -- having a semiconductor diode matrix (un-illustrating) -- this -- a channel -- ****** -- having had -- it works in order to supply energy to a heater element.
[0006]Also in the heat type (thermal) ink jet head 10 of conventional Hewlett Packard, 2 part structures are used so that clearly from drawing 2. However, ink went into the cap 12 via the entrance 13 arranged on the side of the cap 12, and the cap 12 is provided with the nozzle row 14 arranged by intersecting perpendicularly to the entrance 13. Ink comes out through the field of the cap 12. The monotonous heater 15 is arranged directly under each nozzle 14. In this way, the regurgitation of the ink from the inlet channel 13 to a nozzle is caused.
[0007]
[Problem(s) to be Solved by the Invention]However, if it is in a device such conventionally, for the 2 part structure, it faces performing exact registration between 2 parts, and a problem exists. Even if exact registration is able to attain in first stage, this accuracy currently maintained over the range which thermal expansion differs from contraction or becomes may be barred. Generally the problem of such registration has restricted the performance of a device to with a dot number (dpi) per inch of 400 or less image density conventionally. And it has restricted to the scanning type, i.e., a portable printer head, rather than the stationary type printer head.
[0008]The purpose of this invention is to provide the bubble jet print head structure which solves or solves an above-mentioned problem.
[0009]
[Summary of the Invention]This invention deals with one or more of the following

gestalten about bubble jet print art.
[0010]- The picture reproducer and such a bubble jet printing device using the assembly of a bubble jet printing device and such a bubble jet printing device and such a bubble jet printing device which were formed in one. The datcoord machine for the bubble jet printing device bubble jet printing device which has a nozzle to which the included bubble jet print head and different ink of a color are supplied (phaser)
- The bubble jet printing device and recording medium with which the bubble jet printing device, each nozzle, and passage which are arranged so that the heater for each nozzle or a passage may surround the nozzle and passage have extended between the opposed faces of a couple. Width of (calling it paper hereafter) (that is) In the bubble jet print head and such a bubble jet print head containing the bubble jet printing device of length almost equal to the size of the paper which crosses the direction of the relative displacement which passes a device, and is printed. The bubble jet print head and sequence in which the power connection to a device meets the overall length of a device mostly, and is performed for it are made. The arranged nozzle. From a part of method and structure which manufactures the bubble jet printing device bubble jet printing device offset in the direction of a sequence to the nozzle of the sequence which the nozzle of each sequence adjoins with the bubble jet printing device which it has, to other portions of structure heat. The bubble jet printing device and each heater arrangement in which each heater arrangement over the integral-type electronic circuit structure and each nozzle which has an integral-type conductor to transport was provided with two or more heaters which have a corresponding electronic drive circuit, respectively, bubble jet printing device - which the heater and the electronic drive circuit corresponding to this equipped with two or more electronic drive circuits estranged mutually -- at least the reserve or redundant (redundant) nozzle, and main-discharge-nozzle group of a lot, [have and] The detecting circuit which connects between the heaters which correspond about bubble jet printing equipment provided with the heater corresponding to the redundant nozzle which operates at the time of detection of failure of the heater corresponding to a main discharge nozzle, and the intended print position is provided, The bubble jet printing assembly which has two or more bubble jet printing devices it was made to operate other heaters of a nozzle which detect one failure of the corresponding nozzle heater, and correspond.
[0011]Here, the term of "a Z-axis bubble jet chip (ZBJ chip)" is on an XY plane, and in order that the inflow appearance to the chip of ink may describe the chip performed by a Z direction, it is used.
[0012]
[Example]Hereafter, with reference to drawings, the example of this invention is described in detail.
[0013]The ink introduction port where the gross shape of the bubble jet (it carries out abbreviated to ZBJ hereafter) chip 40 of Z-axis arrangement is shown, and this chip 40 was arranged at the flat surface (under this figure) of the chip when drawing 3 of one example of this invention was referred to in the first place first, It comprises two or more nozzles provided with the ink discharge opening of the opposite hand. When drawing 1 and drawing 2 are directly compared with drawing 3, it turns out easily that the thing of drawing 3 is provided with the structure formed by single monolithic accumulation to the structure which consists of two portions of conventional technology. This chip 40 can be

formed using semiconductor manufacturing technology. Ink is breathed out by that ink is supplied to the chip 40, and the uniform direction from the nozzle 41 further again.
[0014]If drawing 4 is referred to next, the section of the 1st example of the ZBJ (that is, it does not move) print head 50 of stillness is shown, This print head is formed so that a continuous shade image may be created in A4 size with an overall length by 1600dpi (a dot/inch) or the image density of 400 pixels/inch. The head 50 is provided with the one ZBJ chip 70 which has a nozzle array of the four nozzle arrays 71, i.e., cyanogen, the magenta 72, the yellow 73, and the black 74. These nozzle arrays 71-74 are formed from the nozzle way (Bahia) 77 which has four nozzles per pixel, and give 51,200 nozzles per chip 70 on the whole. The expansion part of drawing 4 shows the fundamental nozzle section formed in the silicon substrate 76, and the layer 78 of heat SiO_2 (diacid-ized silicon) is formed on the silicon substrate 76. The heater element 79 is formed in the circumference of the nozzle 77, and has covered this element 79 by the overcoat layer 80 which comprises the glass by the chemicals gaseous phase depositing method (CVD). Each of the nozzle 77 is open for free passage to the specific common ink supply channels 75 for color ink. The ZBJ chip 70 can be arranged now on the channel bulged part 60, and this channel bulged part has the common ink feed path 75 and the ink channel 61 open for free passage so that ink flow may be continuously supplied to the chip 70. The one film (membrane) filter 54 is allocated between the bulged part 60 and the chip 70.
[0015]The two power bus bars 51 and 52 are electrically connected with the chip 70. The bus bars 51 and 52 act as a heat sink for dissipating heat from the chip 70 again.
[0016]Drawing 5 indicates that it was shown in drawing 4 by the ZBJ head 20 of the 2nd example of the same structure.
[0017]The head 200 has the ZBJ chip 100 which includes each nozzle array 102,103,104 and 105 of cyanogen, magenta, yellow, and black. The chip 100 has the ink channel 101 and this ink channel is opening it for free passage with the ink tubs 211,212,213 and 214 of each color in the channel bulged part 210, respectively.
[0018]The channel bulged part 210 has other shape with capacity higher than what was shown in drawing 4 to the chip 100 of an identical size. The tab articulated sections 203 and 204 which connect the power bus bars 201 and 202 to the chip 100 are illustrated. The millipore filter 205 as well as the above-mentioned is formed.
[0019]In order to enable printing of the page of A4 size, 220 mm in length, 15 mm in width, and a 9-mm-deep size are mostly needed for the head 200. If the above-mentioned thing as fundamental array constitution is used, the ZBJ head of many gestalten is possible. The dressed size per chip and the number of a nozzle are only decided by the military requirement at the time of printer application.
[0020]Various demands considered to be required for seven examples of application and each example of application of a ZBJ print head by Table 1 and Table 2 are used as the table. It is thought that it is suitable for the full color printer of the 1st low price of the example of application, a portable computer, a low-price color copying machine, and an electronic still picture photograph machine. It is thought that the 2nd of the example of application is suitable for a personal printer and a personal computer, and the 3rd of the example of application is useful to an electronic still picture photograph machine, a video printer, and a workstation printer. As for the 4th example of application, application to a color copying machine, a full color printer, color desktop publishing, and color facsimile

is found out. The 5th example of application is [which is seen by application by digital monochrome copying machine, the high resolution printer, the portable computer, and a regular paper facsimile] for monochrome devices. The 6th of the example of application and the 7th show the useful application by the color copying machine and color desktop publishing which output A3 size by a shade continuously with a ******** high speed and medium speed. As for the high-speed version of the example 7th of application, use with a low operation commercial print and use by the medium-speed version in color facsimile are found out.

[0021]If it is a person skilled in the art to be formed in the ZBJ heads accompanied by the drops (drop) size of 3pl (picoliter), you can understand the above-mentioned example of application correctly. Although the thing of other gestalten is also possible and image quality falls victim, high-speed operation can also be attained by using bigger drop size.

[0022]The physical structure of the ZBJ chip 100 is explained in full detail next. As the ZBJ chip 100 was illustrated to drawing 5, for example, it has the four nozzle arrays 102-105, and this possesses the nozzle way (Bahia) 110 (drawing 6 (A) - (D)) of four rows, respectively. The nozzle way 110 penetrates the substrate 130 of the chip 100 by etching processing, and is formed. The substrate 130 can be made into a length of 220 mm by 4-mm width according to the application which is about 500 micrometers in depth usually, and was demanded. Drawing 6 (A) - (D) shows etching of the nozzle way 110 which penetrates the substrate 130. In order for the ZBJ chip 100 to be able to carry out the regurgitation of the drop of 3pl, the diameter of each nozzle 110 needs about 20 micrometers. In one of the possible manufacturing methods, it is a range shown by drawing 5, and the process of consisting of four stages started with the substrate 300 with a depth of 500 micrometers which has the topping glass (SiO_2) layer 142 which wraps the heater 120 is used. 200-micrometer ** which penetrated the glass overcoat layer 142 and entered at least 10 micrometers in the substrate 130 first at the process shown in drawing 6 (A) -- plasma etching of the round hole surrounded with the wall [immediately] is performed. This forms the nozzle tip part 111.

[0023]The following process etches a big channel (it is a depth of 300 micrometers at a width of about 100 micrometers) from the back side of the chip 100, as shown in drawing 6 (B). The nozzle channel 114 which supplies ink flow to the nozzle 110 by this is formed. In the following process, as shown in drawing 6 (C), a nozzle barrel pattern is printed on the bottom of the channel 114 formed in drawing 6 (B). The nozzle barrel 113 is about 40 micrometers in depth, and plasma etching is made within 10 micrometers ahead of the chip 100. Since isotropic plasma etching is a thing of non-selectivity in comparison, it cannot use for etching total volume in this method, without etching penetrating the heater 120 and damaging.

[0024]So, as shown in drawing 6 (D), isotropic etching is used for a depth of 10 micrometers on all the exposed silicon from the front of the chip 100. The SiO_2 layer 142 bottom which the nozzle 110 can extend and includes the heater 120 by operation of this process is deleted (undercut). The nozzle cavity (cave) 112 is formed at this process. This process makes the nozzle tip 111 connect with the barrel 113 certainly, without exposing to a risk of damaging the heater 120 in plasma etching again. The above-mentioned size is a mere rough value, and what is shown by only the general concept can be correctly understood, if it is a person skilled in the art. However, alignment should be well taken from 10 micrometers and the etching to a rear face from the surface should also make

control of etched depth better than 10 micrometers. Thus, the perfect nozzle way 110 including the tip 111, the cavity 112, the barrel 113, and the channel 114 is formed.
[0025]Probably, as for the structure of the nozzle cavity 112, the nozzle barrel 113, and the nozzle channel 114 which act as the nozzle tip 111 and a thermal action room (thermal chamber), it will be clear that the passage of the ink flow which passes along the substrate 100 for the regurgitation is as ****.
[0026]The conventional accumulated type bubble jet head manufactured in Canon, Inc. uses hafnium boride (HfB_2) as the heater element 120. The Canon BJ10 (part number item) present printer has the heater parameter which chose the drop size of 65pl. Since the drop size of 3pl used in the desirable example of this invention is substantially small, the re set of the size of heater structure is required. In order to maintain another side heater resistance in order to make it become certain to reach an elevated temperature, and to minimize the whole size, the
[0143](12) Elevated temperature : the operating temperature of the ZBJ heater element 121,122 exceeds 300 **. Under the present circumstances, an important thing is that the drive element (a drive transistor and a logic circuit) of the ZBJ chip 100 does not receive such extreme influence of hot. This becomes possible by arranging so that a drive transistor may be detached as distantly [heater element / 121,122] as possible. The above-mentioned drive element can be arranged at the end of the chip 100, and this becomes possible to put only the heater 120 and an aluminum path cord on a high temperature region. It is a serious and potential problem to obtain suitable heat transfer. Although the heater 120 exceeds 300 **, the temperature of the whole chip must be maintained below at the boiling point (100 **) of the ink 106. It is important for heat transfer from a heat sink (51, 52) to the circumference that heat transfer from the chip 100 to not a problem but a heat sink (51, 52) is performed efficiently.
[0144]The scanning ink jet head used for heater drive circuit Canon, Inc. make BJ10 printer has 64 nozzles to which energy is given by the arrangement of the heater 6, as shown in drawing 38. These nozzles are divided into the arrangement of 8x8 using the diode 8 integrated on the chip. The transistor for a drive (not shown) provided outside is used in order to control the heater 6 for eight groups which comprise the eight heaters 6 per group.
[0145]The technique of conventional technology receives [arranging a big nozzle and], and has some inconvenience. all the heater power must be supplied to the 1st via a control signal -- this -- a sake -- a large number -- high current connection is needed comparatively. Similarly, the number of external connection increases dramatically.
[0146]The ZBJ chip 100 which is a suitable example contains two or more drive transistors and shift registers on the chip 100 very thing. By this, it has the following advantage.
[0147](1) Fault-tolerant nature (fault tolerance) is performed at a low price, without needing an external circuit.
[0148](2) All heater power is supplied with the control line which has only a signal level by V_+ and grounding which are two big connection.
[0149](3) The number of external connection will become small regardless of the number of the nozzles 110.
[0150](4) An external circuit can be simplified.
[0151](5) An external drive transistor is unnecessary.

[0152](6) Unlike two transistors and the one diode 8 having been used in conventional technology, only one transistor is used in series with each heater 121,122. Remarkable curtailment of operating voltage is attained by this.
[0153]However, since the circuit of the ZBJ chip 100 becomes more complicated as an inconvenient point of this technique and further more many semiconductor manufacturing processes are needed, it is mentioned that the quantity of production decreases.
[0154]Drawing 39 shows the logic and the drive circuit of the ZBJ chip 100 which have 32 parallel drive lines. These 32 parallel drive lines correspond to the nozzle duty cycle of 32:1. An enable signal supplies a timing sequence and carries out the regurgitation (fire) of each 32 bank included in the nozzle 110 to turn. This enable signal is made on a chip by the clock and a reset signal.
[0155]In drawing 39, Vdd is connected to +5 volt in the grounding point where Vss is pure. Even if V_+ and grounding have the noise included various current, therefore these are dramatically supplied to the chip 100 in low impedance, it is not suitable for a logic circuit.
[0156]The heater driver 124 for the two nozzles 110 is shown in drawing 39. This driver 124 comprises the two individual drivers 160 and 165 for two nozzles (fault-tolerant nature is nothing), and shows the data connection by a shift register.
[0157]Each heater driver 160,165 consists of the following four items.
[0158](1) The shift register 161,166 for shifting data to a suitable heater driver. Since this shift register 161,166 decreases the total of a transistor, it can be used as a dynamic type.
[0159](2) The low-electric-power type dual gate enabling transistor 162,167.
[0160](3) The inside electric power type reversal transistor 163,168. This transistor reverses and carries out the buffer of the signal from the enabling transistor 162,167, and it combines with the enabling transistor 162,167 and it provides an AND gate.
[0161](4) The 1.5-mA drive transistor 164,169. Since the electric capacity on an enabling line is very size, the above-mentioned AND function is not included in the drive transistor 164,169.
[0162]In the ZBJ head which has a nozzle of 1024 (32x32), the clock period is the same as pulse width. Because, it is because the inside of each shift register must be shifted to 32-bit data between nozzle regurgitation, and, thereby, the duty cycle of 32:1 arises. The circuit shown in drawing 39 is suitable only about a ZBJ head with few numbers of nozzles than 1024. However, when it has only a small number of nozzles, an active circuit has only few advantages. Then, a diode matrix is used.
[0163]The clock needed in order that the number of nozzles may shift all the data to a suitable nozzle for a big head from 1024 rather than being size must have a cycle shorter than a heater pulse. In the overall-width high speed full color ZBJ head 200 shown in drawing 5, 51200-bit information must be shifted to the head within 200 microseconds. This needs the clock rate of about 8 MHz. So, the data in the shift register 161,166 must be valid for 125 nanoseconds. However, the data is [be / it / under / all the duration / of a 6.25 microsecond heater pulse / crossing] required. Two solution to this problem is described. There is the one solution in a transfer (transfer) register, and other solution is in a clock pause (pause).
[0164]The arrangement which added the transfer register 172 to the main heater drive circuit 170 is shown in drawing 40. The element of others except this transfer register 172

is equivalent to each element shown in drawing 50. When this arrangement solves the above-mentioned problem, a simple solution will be provided, but there is inconvenience that the quantity of the circuit on the chip 100 increases. 1600-bit data is shifted to each shift register 171 in 8MHz. If an enable pulse arises, the data will be loaded to the transfer register 172 in parallel, and will become stable during the duration of a heater pulse there.

[0165]In order to avoid the excessive transistor of the transfer register 172, a pause part is inserted in the flow of a clock during the duration of a heater pulse. For this reason, data does not change during the duration of that pulse. This is as having been shown in drawing 41. In this case, 1600-bit data is shifted to that register at a rate slightly as quick as 8.258 MHz. Then, a pause arises on a clock for 6.25 microseconds which is a cycle of a heater pulse. Each of 32 rows which constitutes a heater is driven at time different, respectively (fire). The clock for these each sequence can be simply generated by carrying out the gate of the regularity 8.258 MHz clock with a heater enable pulse.

[0166]Drawing 42 has shown one step of the ZBJ drive circuit 177 which incorporates a clock pause part. It is connected to a clock line and an enable signal line, and AND gate 178 drives the clocked into end of the shift register 161 (and 166: although not illustrated, connected to 179).

[0167]This technique has the inconvenience of requiring comparatively complicated data timing of the chip 100. However, when such a thing carries out the order design of the ZBJ datcoord (phasing) chip 310 (it explains later) as shown in drawing 45, it may be supplied at a low price.

[0168]A long clock line: In the overall-width color ZBJ head 200 provided with the nozzle with total redundancy (full redundancy) of 51,200, there is a shift register stage (stage) of 102,400 distributed covering a length of 220 mm. These are constituted so that it may have a shift register of 64 per 1600 steps of each. Needing the transmission-line effect and many fan-outs bars driving on the track where a clock is single. Fortunately, regeneration of the clock is carried out for a short period of time. Supposing regeneration of the clock is carried out 32 times, the number of fan-outs will be set to 50, and each clock classification will serve as a length of 6.8 mm.

[0169]Drawing 43 shows the simple clock reproduction Shigeru arrangement 180. The chain arrangement of the shift register for supplying the corresponding heater driver 124, respectively is included in this arrangement. Schmitt trigger circuit 182 is inserted into the clock line for every regular intervals decided by the number of permissible fan-outs. In the place in which Schmitt trigger circuit 182 exists in the above-mentioned chain arrangement, the shift register 181 in which the next corresponds to drawing 43 so that it may be shown is performing the shift register 181 in front of one to the input from the shift register 181 just before chain arrangement was carried out. By this, the delay imposed by Schmitt trigger circuit 182 is compensated.

[0170]Quality falls off by introducing a propagation delay [in / in the regeneration of a clock / each regeneration stage] (T_{PD}). If the propagation delay of each regeneration machine is substantially shorter than a clock period, the ZBJ circuit will still achieve the function. This is because the data in the shift register 181 of each stage (stage) is similarly delayed by T_{PD} whenever it encounters the clock by which regeneration was carried out. Therefore, a valid data window (window) does not change. When the frequency of a clock is 8MHz, T_{PD} must be smaller than 125 nanoseconds, and must be

larger than the propagation delay of a shift register. This can be attained easily.
[0171]No matter it may be what digital circuit, the difference (T_{PLH}-T_{PHL}) of rise time and fall time exists. In the 2-micrometer ZBJ circuit made from NMOS, such time becomes large considerably. The cause is based on the high capacity nature load and passive pull-up in a clock regeneration machine output. It is a proper assumption to make the value of T_{PLH}-T_{PHL} into 5 nanoseconds. Under these conditions, a clock pulse disappears after the regeneration stage of only 13. The solution is carrying out regeneration of the pulse width for every stage using a monostable multivibrator, as shown in drawing 44. Although drawing 44 corresponds to drawing 43 intrinsically, it differs in that the monostable multivibrator 183 is inserted behind each Schmitt trigger circuit 182 in a clock line.
[0172]The actual pulse width generated by the monostable multivibrator 183 is not criticality-like. It must be longer than the minimum pulse width (about 10 nanoseconds) needed by the shift register 181, and must be shorter than a clock period (125 nanoseconds). When this tolerance level takes into consideration the inaccuracy of each element value in a monolithic circuit, it is important.
[0173]The external drive circuit full color ZBJ head 200 needs the data rate of 32 M bytes/s (8MHz average clock rate x32 bit). Since this data must be delayed till 7600 microseconds, about one M a bit of a delay line memory is needed. In order that the already described clock pause system (drawing 42) may lessen logic of the ZBJ chip 100, when it is used, it is necessary to supply data to the ZBJ chip 100 to complicated timing.
[0174]Drawing 45 is a block diagram showing all the data driving methods of the full color ZBJ head 200, and color pixel image data is outputted on the 32-bit bus 301 by the computer, the copying machine, or the image data generator 300 like other image processing systems. Color pixel image data is usually a raster format (cyanogen, magenta, yellow, and black (CMYK)), and the ingredient of each color is simultaneously supplied to the bus 301. Since it is impossible to make a nozzle and a nozzle close [the nozzle of each color], and to print other colors simultaneously on one color, before supplying different color information to the head 200, it is necessary to delay it suitably. Although the color information which was generated by computer 300 and which is supplied on the bus 301 is digital data of 1600dpi, it simulates the continuous tone color picture of 400dpi using the screen or dither calculated beforehand.
[0175]The bus 301 is divided into the block of an ingredient color (cyanogen, magenta, yellow, and black), and is inputted into the ZBJ head, respectively. The data of magenta, yellow, and black is delayed with the line delay machines 303, 304, and 305, respectively. It is because these colors are printed on turn after cyanogen to each pixel of the head 200. It is used for the address generator 302 supplying color information to the line delay machines 303-305 one by one. As it is used in order that the 8.258-MHz clock 306 may supply all the picture element data one by one, and shown in drawing 45, the power supply group 307 is connected to the head 200.
[0176]10, 20, and a 30-line delay device are constituted using three standard 64Kx8SRAM which has the cycle time of the lead / modification / light for less than 120 ns. Delay **************s an address by the modulos 16000, 32000, and 48000.
On the other hand, SRAM is led and it is carrying out by carrying out the light of the data to SRAM.
The address generator 302 is a counter of the easy modulo 16000, and is generated independently [the address of each SRAM] top 2 bits.

[0177]Since the nozzle of each array is alternate arrangement as shown in drawing 33, the delay to each data line differs. Generally, many standard chips are needed for giving such delay. For this reason, ZBJ datcoord machine (phaser) ASIC310 is used as a buffer of each nozzle array input, and the system is kept from becoming complicated. It can constitute so that 8 bits of every color of four colors may be delayed by one ASIC.
[0178]Drawing 46 shows the block diagram of the suitable data phaser 310 for nozzle arrangement in the example of four nozzles to one already explained color. When using other nozzle arrangement, a time delay must be changed and must be made into proper time. The 50 clock delaying circuits 314, 315, and 316 are formed the purpose so that it may be selectable and the same chip 310 can be used also for which of four colors by the color selection input 313. The color selection input 313 drives the multiplexer which can choose the data output from one data output of the clock delaying circuits 314-316, and the direct data entry 312.
[0179]ASIC310 shown in drawing 46 is a very easy structure, and needs about 56K a bit of data storage equipment. this -- therefore, a standard cell -- or it is the most suitable for the data path compilation method.
[0180]The data connection 327 to a ZBJ head is related to the driving order which determines the length of required delay. Here, driving order is determined by adding the number (black =0, yellow =1, magenta =2, and cyanogen =3) specified as "c" which shows a color.
[0181]The enable pulse generator 326 supplies an enable pulse to the heater driving circuit 124 (it already explains).
[0182]In order to fit a full color overall-width ZBJ head to the mega-market of the color copying machine sold at less than about 5000 U.S. dollars of costs of a ZBJ head, and a printer, the manufacturing cost of the head must be made as cheap as possible. When the process which matured is generally used for the target price to each head, volume is about 100 or less U.S. dollars.
[0183]the ZBJ head 200 is single piece structure intrinsically -- the cost of the head -- all are almost the cost of ZBJ chip 100 itself. The cost of the ZBJ chip 100 is decided by the process cost per wafer, the number of the heads per wafer, and the yield.
[0184]If the process cost per wafer considers it as the about 800 U.S. dollars, the number of the heads per wafer will be 25, and the previous process yield (pre-yield) cost per head will become the 32 U.S. dollars.
[0185]In order to cover the expenses [U.S. dollars / 100] of the cost of a head, the yield of the process which matured must be about 30%. However, the chip area of the full color overall-width ZBJ head 200 is an order of 8.8-cm^2. If it carries out from this size, even if the yield of a chip will be a person skilled in the art as it becomes close to zero, although it will believe, there are some factors and the anticipation yield does not become low so much at the beginning. If these factors are raised, the great portion of (1) chip 100 will consist of a heater, a nozzle tip, and a path cord, and this will not affect the point rearrangement (point dislocation) of a silicon wafer.
[0186](2) The typical size of the great portion of chip 100 is not less than 3 micrometers, and is not comparatively influenced to very small particles.
[0187](3) a wafer -- the chip 100 is not influenced by semiconductor machining steps in a field with a possibility that it may be influenced by climax of the radius of circle depended dirtily and resist edge or process shadowing (that is, there is no active circuit

element near the nozzle).

[0188]It is desirable to give redundancy to the degree of fault-tolerant of a ZBJ head (fault tolerance), although the yield is improved. By giving redundancy to fault tolerance, existence of very many defects can be permitted and operation of a nozzle is not influenced. Although it is not necessary to make redundancy 100%, it is necessary to make the non-redundancy region of a head small to the size which raises always sufficient yield. The effect which fault tolerance exerts on the yield is mentioned later. There are some factors which use the yield below as an appropriate level about fault tolerance. When some of factors are mentioned, it is dispersion on (1) processing. Processing parameters called the depth and sheet resistance of etching vary in the wide range exceeding a tolerance limit with dispersion on processing, and the yield of the wafer which received the influence becomes zero. The acceptable value of these parameters is made to agree in a production-design stage generally by ZBJ head demand quality.

[0189](2) Mechanical damage : if so proper that the mechanical strength of a ZBJ head is equal to any design at working stress, the design of ZBJ is correctable so that it may have sufficient intensity. However, if a design is changed, a chip area will be made into a sacrifice and the yield will usually be made into a sacrifice.

[0190](3) Wafer taper : the ZBJ chip 100 is usually extremely influenced by the wafer taper by back etching of the nozzle 110. It is necessary to grind a wafer so that a taper may be set to less than 5 micrometers before processing.

[0191](4) Slide : in the chip 100, if a wafer is prolonged on the whole, the yield will become zero with a large slide defect. A special furnace design and processing technology can be used and the wafer of a long rectangle can be accommodated.

[0192](5) Etching depth : the whole wafer must be covered and etching depth must be made less than 5% so that the plasma etching of a barrel may not etch a heater. When not fitting in this acceptable value, it will be necessary to correct so that the influence of dispersion in etching of a specific ZBJ design may decrease.

[0193]photograph tolerance (the degree of fault-tolerant) -- as already stated, in order to also lengthen the life of a head, the concept of fault tolerance is included in the ZBJ chip 100 as well as the yield. It is thought that the measure against fault tolerance is indispensable in order to measure the reduction in the manufacturing cost of the ZBJ chip 100. Although especially the concept of the fault tolerance said here is suitable for the ZBJ chip 100, it is [concept / same] usable also to BJ head of other types in it being the structure of having two heaters per nozzle.

[0194]The demerit of fault tolerance is that a chip becomes complicated twice. However, a chip area only becomes large slightly (about 10%) according to the fine structure of the nozzle 110. Reduction of the yield resulting from this is farther [than the increase in the yield by introduction of fault tolerance] small.

[0195]In the ZBJ system described here, fault tolerance is introduced by forming the two heater elements 121 and 122 to each nozzle 110. The nozzle 110 is annular, as for these heater elements, since it is shown in the surface of the chip 100, it is equipped with each heater 120 so that the two heater elements 121 and 122 may be located in the side which the nozzle 110 counters mutually, and it is preferred to have the same geometry. As shown in drawing 47 (A) and drawing 47 (B), a heater element may consist of the main heater 121 and the redundant (redundant) heater 122, and the structure shown in drawing

10 may be used for it. Therefore, an ink droplet is intrinsically breathed out from the nozzle tip 111 with the same heater 121 or 122.

[0196]Control of the redundant heater 122 for fault tolerance is made by detecting the voltage of the drive transistor of the drive circuit of the main heater 121. In this node, whenever the nozzle 110 drives, change to LOW takes place from HIGH. Three failures are detected by operation of this node.

[0197]1. heater open circuit: If the heater 121 is disconnected, a node will maintain LOW.

[0198]2. An open circuit of a drive transistor : if this occurs, a node will maintain HIGH.

[0199]3. The short circuit of a drive transistor : when a transistor short-circuits, a heater is overheated, and disconnect and a node remains in LOW.

[0200]Drawing 48 shows the one drive circuits 185 and 186 for nozzles of the ZBJ chip 100, and this chip 100 has the fault tolerance realized as a digital circuit sampled from the drain of the drive transistor 164 of the main heater 121.

[0201]The latch 189 memorizes the failed state detected when a node was set to LOW, when the drive of the heater 121 stops. The driving signal of the drive transistor 164 of the main heater 121 performs the output to the AND gate inputted similarly, and the latch 189 shows what the heater 121 should be operating. Other AND gates 190 detect the break state of a drive transistor. Two AND gates 190 and 191 are connected to the input of OR gate 192 in order to control the redundant heater 122.

[0202]Since the pulse width and voltage of an arithmetic circuit are stable in the narrow field, the digital circuit of drawing 48 can be transposed to simpler analog circuitry as shown by drawing 49. With this composition, the capacitor 194 and the diode 196 generate a pulse, whenever an arithmetic circuit changes from HIGH to LOW. This pulse forbids the drive of the redundant heater 122, while the circuit of the main heater 121 operates. If the main heater 121 breaks down, the redundant heater 122 will drive to the timing which the main heater 121 should drive.

[0203]The value of component parts having a pulse longer than heater operating time (6 microseconds), and becoming shorter than pulse repetition time (200 microseconds) is determined. This means that the acceptable value of parts is large.

[0204]Since the heaters 121 and 122, the drive transistors 164 and 193, and related connection form not less than 90% of the area of the ZBJ chip 110, the fault tolerance of a remarkable grade is obtained by giving redundancy only to this field. However, protection is made only to a small region defect. The defect of a larger diameter than about 10 micrometers causes failure.

[0205]Fault tolerance is easily extensible so that the 100% redundancy of the circuit of the ZBJ chip 100 may be included. Simultaneously, the tolerance of a certain amount of failure by the defect up to 600 micrometers in diameter is also obtained. This can be attained by providing doubly the shift register 181 and drive circuit which were already described. Since the shift register 181 does not occupy a chip area greatly, the cost cut by the improvement in the yield exceeds the cost hike by this doubleness.

[0206]Drawing 50 shows one step of the ZBJ drive circuit which gave perfect redundancy. Here, the main drive circuit 187 is doubled and the circuit (the resistance 250 and capacitor 199) where the main circuit 187 forbids the drive of the redundant circuit 188 during an operation simultaneously is added.

[0207]Drawing 51 (A) and (B) shows arrangement of the simple chip of the small section

of the ZBJ chip 100 which realizes extensive field fault tolerance. Although large field failure of a drive circuit is corrected, only small region failure is corrected in a nozzle region. This is because the main heater 121 and the redundant heater 122 exist in the same nozzle 110. However, a nozzle region is not influenced by failure in most mask layers excluding an active device.

[0208]a main circuit -- or the defect which destroys the shift register of a redundant circuit means that the next driving steps do not have fault tolerance. The pile of failure by the data sequence of the Lord or a redundant shift register (stuck-high fault) causes failure of a chip which between Vss and Vdd short-circuits. However, failure of this type only occupies the small percentage of the failure considered.

[0209]As shown in drawing 51 (A) and (B), if the placed opposite on the chip 100 of the main circuits 156 and 158 and the redundant circuits 157 and 159 is used for the circuit of drawing 50, it will cause a problem. The problem is that it will cross the chip 100 and will form a loop similarly if the power connection to the preliminary driving transistor 193 is shown in drawing 52. This loop occupies a remarkable chip area and makes two times the total of the high-electric-current track which crosses a chip. This is solvable if the series connection of the redundant heater 122 and the redundant drive transistor 193 is made reverse. This requires introduction of the level translator 257 for controlling the redundant drive transistor 193. This is shown in drawing 53 and one step of the ZBJ drive circuit designed for large field fault tolerance is shown here.

[0210]About 50% of the surface of the chip is formed by the aluminum connection between the drive transistors 164 and 193 and the heaters 121 and 122. Since these connection uses the line of minute width, their a possibility that a defect will occur is also high. Table 3 indicates the result to be a failed state which may happen when the influenced head circuit considers that even free has a defect.

[0211]Each state where it is enumerated in Table 3 has fault tolerance except for the case where the two main drive tracks short-circuit. Fault tolerance is obtained when this inserts a fuse between each main drive transistor 164 and its heater 121. However, although this fuse needs to be dramatically high-precision and the heater current dissolves by two times, don't dissolve in 1 time. More nearly elegant solution is putting the main drive track with a redundant drive track. This composition increases defect size required to short-circuit the two main drive tracks only 3 times. Such composition reduces the defect density by this source of release only 9 times.

[0212]The composition for performing above fault TORARENSU is made by doubling the heater 120 on a nozzle level. However, exact operation is not guaranteed if the nozzle 110 blockades this. If this happens, it is necessary to obtain fault tolerance by doubleness of a nozzle array with a chip level, as shown in drawing 54.

[0213]here the ZBJ chip 450 of a redundant nozzle is shown -- this -- the main cyanogen nozzle array 451 and the redundant cyanogen nozzle array 452 -- and -- the same -- the array of the same composition of magenta (453, 458), yellow (455, 456), and black (457, 458) -- an owner -- it carries out. With this composition, failure of one of the nozzles of the main array will drive the nozzle to which a redundant array corresponds. This is explained by drawing 54, is driven with the heater 461 with which electric power was supplied to the main cyanogen nozzle 451A via the switch 460, and also drives the redundant cyanogen nozzle 452A with the same heater 463 and the switch 462 here. The failure detector 464 which detects failure of the main cyanogen nozzle 451A has

connected the switches 460 and 462, and this inputs a drive pulse into the switch 462. It is necessary to compensate both either [of those] the time about relative movement of the paper which crosses the chip 450 or a motion for the physical displacement of the array 452 to the array 451. It detects all breaking down [that this can be broken down and this shift register generates for the nozzle of a single tier with the shift register 465 of parallel load], and that data output is shifted as a flow of serial data. After this serial data is delayed by a suitable number of line delay, it is inputted into a serial-parallel conversion shift register, and is used for this data starting the redundant heater 463 with the redundant switch 462 there.

[0214]The fault tolerance of a system level is obtained in a way as shown in drawing 56, and the two thermal ink jet chips 470 and 475 are arranged as **** there. The chip 470 operates as a main device and the chip 475 operates as a redundant device. Therefore, the arrays 471 thru/or 474 are compensated with a method which was already described by the arrays 476 thru/or 479. However, each nozzle 480 must be connected to the corresponding nozzle 481 with this composition, using the failure detector 482 and the compensator 483 like [former]. This shifts fault data from the main tip 470, is delayed in it, and is attained by using it, since the nozzle of the redundant chip 475 is driven further.

[0215]They are very long and thin, and also since dicing and the handling ZBJ chip 100 have a hole of a large number installed by etching, the conventional method of the mechanical strength of the chip 100 is insufficient [the chip] for making high dicing of the yield possible.

[0216]the diced back -- being dirty (diced back etch) -- the easy solution to be used is illustrated by drawing 57. In drawing 57, the most penetrates a wafer at the back of the wafer 149, and the channel 147 is formed in it by etching. Subsequently, the wafer 149 has the notch 145 formed in a front face. The channel 147 can be etched using the same process as being used for etching the ink channel 101 and the nozzle way (Bahia) 110. The interval of Bahia 146 along the dice line 145 can be adjusted, and balance of the intensity for handling and the ease of dicing can be made the optimal. It must be cut off by dicing before the ZBJ chip 100 is separated. If the tag 148 is 5-mm width, for example, it must set the length of the wafer to a 220-mm head to 230 mm. The wafer 149 has prevented the field of the ZBJ chip 100 from supporting with these tags 148 and being influenced by the "shadow" (shadow) of processing among various chemical treatment processes.

[0217]The sizes of the lithography overall-width color ZBJ chip 100 are about 220 mm x 4 mm, and are demanding still very thin line width like 2 micrometers from four nozzles from one nozzle per 3 micrometers and pixel per pixel. When forming a resist pattern, it is difficult to maintain a focus and resolution, but it is in the limit of the present art.

[0218]Either all the wafer projection printings (projection printing) or an optical stepper can be used. 220-mm movement of both needs to add change to a major axis by the ability to be made to do at a stage.

[0219]In 1:1 projection printing, a scanning projection printing machine is changed so that a very long mask may be permitted and a mask transport mechanism may be adjusted. Since the defect started by the particles on a mask is projected by the ratio of 1:1 and it is united in the focus, pure conditions are required by attaining the same defect level. 1:1 printing machines require the mask of an image surface product (220 mm x 104 mm) again. For this reason, it is necessary to add change to a mask manufacturing

method. Although production of a mask with a resolution of 2 micrometers of this size is possible about mass manufacture, it is dramatically expensive also at small capacity. It is necessary to examine stepper shape from these reasons.
[0220]If a 5:1 reduction stepper is used, it will reach in the problem which coils round a scanning projection printing machine especially the problem related to manufacture of a very big mask, and ********, and the particle contamination of a mask will decrease. However, some new problems have occurred. First, different imaging areas of 10 mm x 8 mm are used. And image formation of the overall-width wafer can be carried out at 22x13 processes. Thereby, printing is provided with these all the 286 processes for about 250 seconds as a whole.
[0221]Since the imaging process of about 10 is needed for manufacture of the ZBJ chip 100 and all the exposure time per wafer can also be about 2500 seconds, the production rate of such a device falls substantially. If a stepper is used, the following two problems will arise and the design of a ZBJ chip will be affected.
[0222]1. The ZBJ chip 100 is longer than step size in one axis.
[0223]2. During exposure of a wafer, since a mask is easily unchangeable, it must use one mask for all the heads.
[0224]The 1st thing is conquerable among these problems by using a repeated pattern and guaranteeing that the consistency in the circumference of the repetition block is not important in criticality. Since dicing of the wafer 149 is carried out only to one way, the repetition block does not need to be a rectangle, but extreme shape like a nozzle is avoidable. As long as they consistent mutually, irregularity may completely be sufficient as the both the right and left ends of a mask pattern.
[0225]Each signal wire must end in the bonding pad 207,223, and, typically, these bonding pads 207,223 are arranged at the side edge of the chip 100. Thereby, it is required that image formation of the side edge of the ZBJ chip 100 should usually be carried out by a different pattern from the central pattern of the ZBJ chip 100. This blades a mask and is attained by dimming a bonding pad and the accompanying circuit to all other than exposure of the beginning of a chip.
[0226]Drawing 59 shows the layout of the fundamental floor design of the stepper mask for overall-width continuous tone color ZBJ chip 100, or a chip, and contains the perfect redundancy of whole surface fault tolerance. The expansion part of drawing 59 shows the irregular mask boundary 258.
[0227]Although the ZBJ manufacturing method ZBJ chip 100 is processible by the standard semiconductor process method and the well alike method, some excessive work processes are required. These are exact wafer thickness control, vacuum evaporation of a HfB_2 heater element, etching of a nozzle tip, back etching of an ink channel, and back etching of a nozzle barrel.
[0228]It is because it is the foundation of four nozzles per pixel that the 2micromNMOS method using two-layer (level) metal is adopted. The CMOS method or bipolar ** can also be used.
[0229]Manufacture of the wafer for scanning BJ head is the same as that of the thing for standard semiconductor devices except that it is necessary to also grind the back correctly and maintaining wafer thickness to not less than 5 micrometers. The both sides of a wafer are processed by the photolithography and this is because the etching depth from an opposite hand is important.

[0230]An overall-width fixed ZBJ chip needs manufacture of a different wafer from the chip used for scanning a head. It is because the ZBJ chip must be not less than 297 mm in length to not less than 210 mm in length, and A3 page in order for this to be able to print A4 page. This is much broader than the cylinder of a typical silicon crystal. The wafer can provide the long chip needed by slicing this cylinder to shaft orientations.
[0231]When a wafer is ground, generally the obtained wafer is about 600-micrometer thickness. The obtained wafer is a rectangle of 104 mm x about 230 mmx600-micrometer thickness. All the color heads of about 25 are processible on this wafer. The wafer and appearance of drawing 58 are [such wafer] similar. Before the yield is lost using a with 230 mm in length, and a diameter of 6 inches cylinder, all the a maximum of 2600 overall-width color heads can be manufactured.
[0232]Since the ZBJ print chip 100 is 1 piece structure and it is using the stepper for exposure, it is not severer than a transistor manufacturing method. [of the demand of the surface smoothness of a wafer] Although gettering of the wafer can be carried out using back paste ******, since a damage on the back may arise, it is not recommended. This is because the back is etched succeedingly.
[0233]Wafer processing of the ZBJ chip 100 uses the standard method used for the combination of a special method and drive electronic circuit manufacture which are needed for heater vacuum evaporation and nozzle formation. The size of the ZBJ chip 100 does not have an advantage on not the drive transistor 164,193 but the size which uses a very precise method since it is mainly decided by the nozzle 110. although the method indicated in this specification is based on the 2-micrometer self-align polysilicon gate NMOS method -- CMOS and bipolar ** -- other methods [like] can be used. The process size indicated here is the maximum size which suits the Inta connection density needed for the nozzle 110 of a high density 4 color ZBJ head. This also needs two metaled layers (level). Although two metaled levels may be needed for a simpler head, this is because a high current track crosses a chip, and is formed and the very long clock track is formed along with the chip.
[0234]The wafer work process needed for formation of the ZBJ nozzle 110 is needed with the process needed for a drive transistor, and is mixed. Since the method currently used for the drive transistor may be standard so that it may be publicly known to a person skilled in the art, it is not necessary to specify such a process in this specification.
[0235]Wafer processing of the ZBJ chip 100 is illustrated by drawing 60 - drawing 69. Drawing 60 - drawing 69 show the section of the single nozzle corresponding to the profile line illustrated by drawing 9. Drawing 60 - drawing 69 also show the simultaneous structure arranged at the outside (outboard) of a nozzle array of corresponding.
[0236]First, if drawing 60 is referred to, the 0.5-micrometer layer 132 of thermal SiO_2 will be grown up on the p type dope board 130. Pattern formation of a thing required for a drive circuit and heat shunt Bahia (thermal shunt vias) 400 is carried out to this.
[0237]Next, if drawing 61 is referred to, a thin gate oxide will be thermally grown up on the substrate 130. If it carries out like this, the electrical junction to the substrate 130 of the heat shunt 140 will be affected, but heat conduction is hardly influenced. Polysilicon is deposited and the gate 403 of a transistor and the Inta connection are formed. The n type dope of the drain and sauce of a transistor is carried out using the polysilicon gate 403 as a mask. This dopes the heat shunt terminal area 403 to the substrate 130 again.

The 0.5-micrometer layer of HfB_2 is deposited and the heater 102 is formed. The 0.5-micrometer layer of aluminum is deposited on the substrate 130, and the 1st layer of the metal 134 is formed. The pattern with which a heater and the 1st layer metal 134 were aligned is formed in resist, and wet etching is carried out by a nitrate phosphorate etching agent. Reactive-ion-etching processing of the HfB_2 layer is carried out using aluminum as a mask. This etching is performed using halogen nature gas like CCl_4 (carbon tetrachloride) as indicated in the U.S. Pat. No. 4889587 gazette. Thereby, a wafer becomes the stage illustrated by drawing 61. A mask shows the grounding common track 405 and the V_+ common track 405.
[0238]Subsequently, the pattern which exposes the heater element 120 is formed in resist, and wet etching treatment is carried out by a phosphoric acid nitric acid etching agent. A wafer will be illustrated by drawing 62 if it does so. Drawing 62 shows the heater bonding electrode 407 under aluminum, and $HfB_2$400 again.
[0239]If the aforementioned process is followed, the 500A thickness layer of HfB_2 will arise under all the 1st layer of the metal 134. This contains the connection with the sauce and the drain of all the FET in a control circuit, and a Schottky diode. If necessary, other masking and RIE etching can be used before deposition of aluminum, and HfB_2 can be removed from the field which is not desired.
[0240]Drawing 63 explains formation of the oxide 136 between layers (interlevel). This is a $CVDSiO_2$ layer of about 1-micrometer thickness. This layer thickness can be decided according to the heat transfer delay (thermal lag) needed between the heater 120 and the heat shunt 140. Drawing 63 shows the wafer section after this process. In drawing 63, the numerals 410 are heat shunt Bahia and Bahia for connecting 411 to a nozzle cavity and connecting 412 to a transistor and 413 are heater connection Bahia.
[0241]Reference of drawing 64 will form the 2nd layer (level) metal 138 as a 0.5-micrometer aluminum layer. Both the interconnecting parts 144 of the 2nd layer and the heat shunts 140 are formed. [as opposed to the heater 120, the heater terminal area 416, and the terminal area 415 for drive circuits in this layer] Although it cannot think that the metal of two levels is required for a ZBJ head with one nozzle per pixel, there may be a required thing in a high-speed color head with four nozzles per pixel. This layer thickness and material are changeable so that the thermal demand of a heater chamber may be suited according to a specific use.
[0242]Reference of drawing 65 will apply the CVD glass overcoat 142 to the thickness which is about 4 micrometers. A low-temperature CVD method like PECVD can be used. This layer is dramatically thick and has given a mechanical strength and environmental protection to the nozzle tip 417. 4-micrometer glass overcoat is penetrated with a SiO_2 etching seed, and a hole 17 micrometers in diameter is formed of a RIE etching process. Thereby, the crowning of the nozzle tip 417 is formed and the structure illustrated by drawing 65 is completed.
[0243]The hole (417) formed of RIE of SiO_2 is extended by at least 30 micrometers by performing RIE further using silicon etching gas. In this case, SiO_2 overcoat is used as a RIE mask. Since it is non selection-like [RIE] in comparison, most quantity of SiO_2 overcoat falls victim. For example, since CVD glass overcoat will be deposited in 10-micrometer Fukashi if an etch rate is 5:1 ($Si:SiO_2$), 4 micrometers remains after etching of silicon. This hole (417) can be etched as deeply as possible, and can lower the requirements for the accuracy of the depth of back etching of a nozzle barrel (113) to

minimum. Reactive ion etching is used for acquiring a vertically near side attachment wall.
[0244]The back etching process of the wafer is carried out to a thickness of about 200 micrometers. However, actual thickness is not important and change of thickness is important for it. It is necessary to carry out the etching process of the wafer so that change of thickness may be set to less than **2 micrometers with the whole wafer.
[0245]It is difficult to guarantee that the method of carrying out the back etching process of the nozzle carries out Oba etching of the heater, and does not break after that unless this is attained.
[0246]The following step to 4 color head is RIE etching of the ink channel 101 which is in the back side of the surface of the chip 100 by the method shown in drawing 6 (A) - (D). These ink channels 101 are about 600 micrometers in width, and are about 100 micrometers in depth. Although these ink channels 101 are not indispensable for operation of the ZBJ chip 100, there are two advantages. That is, the channel 101 decreases the flow of the ink in a filter to a second in about 8 mm/second to about 2 mm /. Reduction of this flow can be attained also by putting a filter on the ZBJ head 200 independently. With the channel 101, the depth which should etch the nozzle 110 decreases from 190 micrometers to 90 micrometers. Since the nozzle barrel 113 is 40 micrometers in diameter, the depth which should be etched has big influence on the length versus diameter ratio of the nozzle barrel 113.
[0247]However, the ink channel back etching 420 has a fault which weakens the intensity of a wafer substantially. This step can be skipped if you wish.
[0248]The method shown in drawing 57 is used for an ink channel back etching process in front, and it can use it also for making thickness of a wafer thin along the dice line (dice lines).
[0249]The depth of etching of the following step, i.e., the depth of the back etching 419 of a nozzle barrel, is dramatically important for the nozzle barrel 113 combining with the tip 417 (111) of a nozzle suitably, and constituting a thermal action room (thermal chamber). The solution of this problem is adopting the etching end point detector method by an optical spectroscopic analysis. The tip 417 of the nozzle beforehand etched from the transverse plane of a substrate can be chemically filled with the detectable mark (signature), and a chemical etching stop signal can be generated by monitoring emission gas with an emission-spectrochemical-analysis machine. The nozzle barrel 113 carries out anisotropy reaction ion etching of the silicon, and forms it. A hole (expanded to 60 micrometers by isotropic plasma etching later) 40 micrometers in diameter is etched into a depth of 70 micrometers into silicon from the rear face of a wafer. These holes are located at the bottom of an ink channel with a depth of 100 micrometers etched beforehand. Since thickness of a wafer is made thin to 200 micrometers, these holes are etched into less than 30 micrometers from the surface of silicon.
[0250]If the detecting signal of the terminal point 421 comes out from a spectroscopic-analysis machine, even if some nozzles have not combined with a tip, etching will stop. This reason is the following step (10-micrometer isotropic etching of the exposed whole silicon), and is because all the less than about 12-micrometer nozzles combine with a tip. Drawing 66 shows the ZBJ chip in the end time of this step.
[0251]It is important that the depth of etching is uniform on all the wafer surfaces. It depends for a tolerance limit on the depth of each hole which can mainly be attained

about the 18-micrometer hole etched from the surface of a chip. When the hole etched from the surface is etched into the depth which is 30**2 micrometers, The thickness of a wafer the depth of 200**2 micrometers and ink channel back etching 100**4 micrometers, In the isotropic etching of the whole silicon, 10**1 micrometer and 12 micrometers of the maximum bond distances (maximum joining distance) reach, As for the maximum distance of a nozzle barrel and a heater, 10 micrometers and an accumulation allowable limit mean that etching of a nozzle barrel must be 70**4 micrometers. Supposing it can perform surface etching more deeply than 30 micrometers, restriction of all these allowable limits can be eased. Since the alignment at a nozzle barrel and a tip is not so important for the alignment accuracy over the surface process of a back etching process, what is necessary is just less than **10 micrometers.
[0252]The summation effect of these allowable limits is illustrated by drawing 67. The field 424 which gave crosshatch shown in drawing 67 is an undecided region in the shape of a final nozzle, and the field 423 which performed single hatching shows the safety clearance of the combination to the nozzle tip of the nozzle barrel for which it asked using these allowable limits. In reactive ion etching, the bottom of the thing which needs safety clearance is for a completely flat hole not to remain. Since it was not much large in order for the channel to have shown with this figure, thickness (200**2 micrometers) of the undecided region of a wafer and etching (depth) (100**4 micrometers) of the channel were made into a number with one thickness [in all] of 100**6 micrometer.
[0253]Another small problem exists in this step. On these problems, resist so that even 70-micrometer RIE may be maintained, Problems, like the surface of that it is problematic to removal of a used etching agent since it having to be dramatically thick and etching are deep and it is narrow, the thing for which a shadow should be prevented from being made to a projection pattern with the wall of an ink channel, and the shape of a stage must be appropriately covered by resist are included. Since etching of the wall of an ink channel is permitted, this is not important.
[0254]However, the actual form or size of the back end of the nozzle 110 are not important. For this reason, another extensive solution is employable. A required thing is forming the form which the minimum mechanical strength's is held and produces the capillarity of ink. Some possible alternative plans are as follows.
[0255]- It is usable in multi-stage RIE about the barrel 113 which becomes narrow gradually. Although the problem that multi-stage RIE has that a used etching agent accumulates and a thick regist layer is avoidable, much more processing steps are contained.
[0256]- Etching of the large hole which includes some of nozzles 110 about the nozzle by which grouping was carried out so that space between holes might be made into the maximum. Thereby, a mechanical strength is maintained. This is illustrated by drawing 70.
[0257]With the whole ZBJ wafer, 10**1 micrometer of isotropic plasma etching is performed to the exposed whole silicon. There are two purposes in this. The 1st purpose gives undercut one 425 for the heat diacid-ized silicon 132 in the field of the heater 120, and forms the thermal action room 115. Thereby, combination with the nozzle barrel 113 and the tip 111 of a nozzle is ensured. This is produced from the breadth 426 of the barrel 113. Since a wafer is etched in the both sides, the barrel 113 and the tip 111 within 18 micrometers (10-1) (twice of mum) which have not been combined yet must join together

altogether. An uncombined barrel and tip less than about 12-micrometer operate like the barrel and the tip which were combined. This eases the accuracy conditions of the rear-face etching 419 of a barrel.
[0258]Etching must be highly alternative to silicon, and the etch rate to heat diacid-ized silicon is indispensable, so that it can be disregarded. The heater insulating layer will be destroyed when that is not right. It becomes the composition illustrated to drawing 68 as a result.
[0259]Next, in order to expose a bonding pad, the overcoat 142 of 4-micrometer glass must be etched. Don't perform this before nozzle tip silicon etching. It is because selectivity is inferior, so 30-micrometer RIE silicon etching through the aluminum layer 139 will be performed.
[0260]Then, a passivation layer can be built with the layer 144 of 0.5 micrometer of tantalum, or another suitable material for the ZBJ chip 100. Although it is difficult to realize high coating of conformity, the irregularity of the thickness of a passivation layer does not have substantial influence on the performance of the ZBJ chip 100.
[0261]Since a ZBJ chip does not have an electrical output, a actual functional test can be carried out by performing pattern printing which fills ink to a device and makes each nozzle 110 drive. This cannot be performed in multi probe time. The effective method of doing the functional test of the chip 100 in multi probe time is driving each heater 120 in order, grounding V_+, and measuring power consumption. Whenever it drives each heater 120, a current pulse certainly occurs. Since this is a separation circuit through which quiescent current to the extent that it can ignore flows, these pulses are detected easily. Therefore, a working heater and the pattern of the whole redundant circuit can be determined using cheap equipment in about 1 second. Therefore, the multi probe of the whole wafer can be carried out within 1 minute. The pattern of a heater of operation and the heater which does not operate is read into a computer, compiles process statistics, and is used for detecting a partial quality control problem.
[0262]A scribe is performed over the upper surface of etched dice channel (dice channel)147 (refer to drawing 57). Before separating the ZBJ chip 100, weld tab (end tabs)148 for handling must be separated. The proper place of the head assembly 200 is pasted and the chip 100 is connected by tape automated bonding on one tape along the both ends of a chip. Or standard wirebonding can be used if bonding of the wire of sufficient length to satisfy high-electric-current demand use (high currentrequirements) of the chip 100 is carried out. Drawing 69 is illustrating the section of the completed device.
[0263]Drawing 71 is a top view of the typical component used for the ZBJ chip of the structure shown in drawing 15. Drawing 72 thru/or Drawing 102 are drawings of longitudinal section which pass along the center line of drawing 82 in a different manufacturing process.
[0264]Drawing 72: start a manufacturing process using the silicon wafer of the p_- type standard doped by resistance of about 25-ohm cm.
[0265]Drawing 73: the layer of the silicon nitride 501 of about 0.15-micrometer thickness grows on the wafer 500. This is a standard NMOS process.
[0266]Drawing 74: the 1st mask 501 is used for patterning of the silicon nitride 501 for carrying out boron pouring.
[0267]Drawing 75: boron is poured into the field 503 in order that the wafer 500 may prevent formation of a similar transistor.

[0268]Drawing 76: the heat oxide layer 504 of about 0.8-micrometer thickness grows on the boron pouring field 503.
[0269]Drawing 77: the remains silicon nitride 501 is removed.
[0270]Drawing 78: this is the standard NMOS process of pouring in arsenic, in order to form the field 505 for depletion mode transistors. This process includes spin deposition of resist, exposure of the resist through the 2nd mask, the development of resist, pouring of arsenic, and removal of resist.
[0271]The gate oxide 506 of 9:0.1 micrometer drawing 7 grows thermally. This is a part of standard NMOS process.
The thickness of a field oxide is made to increase even to 0.9 micrometer.

[0272]Drawing 80: Deposit a 1-micrometer polysilicon layer on the wafer 500 whole using chemical gaseous phase deposition.
[0273]Drawing 81: the polysilicon 507 is patternized using the 3rd mask 508. The spin coat of the wafer 500 is carried out using resist. This resist is exposed and developed using the 3rd mask. Next, the polysilicon 507 is etched using etching promoted with anisotropy ion, in order to reduce ANDAKATTO.
[0274]Drawing 82: the gate oxide 506 -- the poly lithospermi radix of the 3rd mask -- etch the portion therefore exposed dirtily. A result to which the dirty diffusion windows 509 are formed, 0.8 micrometer in thickness is removed by this, and the field oxide 504 becomes thin is brought.
[0275]Drawing 83: the N^+ diffusion region 510 of the about 1-micrometer depth is formed into the diffusion windows 509.
[0276]Drawing 84: Deposit the glass layer 511 of 1-micrometer thickness using chemical gaseous phase deposition.
[0277]Drawing 85: the CVD glass 511 is etched in the portion for which to connect the polysilicon 507, the diffusion region 510, and into a heater field is needed. The connection region 512 is formed. This process differs from the standard NMOS process. In this standard NMOS process, the depth of that etching is controlled so that the suitable quantity of heat $SiO_2$504 which remains under a heater exists.

[0278]The HfB_2 layer 513 of 6:0.05 micrometer drawing 8 is deposited on the wafer 500. This is not a standard NMOS process.
[0279]Drawing 87: the HfB_2 layer 513 is etched by etching promoted with ion using CCl_4 as ECHANTO. Here, the heater 514 is exposed. In this process, the exposure to the spin coating of resist and the mask of the 5th level, the development of resist, etching promoted with ion, and resist removing are needed.
[0280]Drawing 88: the 1st metallic level 515 of 1 micrometer that consists of aluminum is vapor-deposited on the wafer 500.
[0281]Drawing 89: the 1st metal layer (level) 515 is etched using the mask of the 6th level. In this process, the spin coating of resist, the exposure to the 6th mask, the development of resist, plasma etching, and resist removing are needed. A HfB_2 layer is only 0.05 micrometer.
Since it is exposed when the metal 515 is etched, this etching must be alternative enough on HfB_2.

[0282]Drawing 90: Deposit the 1-micrometer glass layer 516 using CVD.
[0283]Drawing 91: pattern contact for the masks of the 7th level is performed using 2-micrometer standard contact etching for NMOS which has metal of a double level. In this process, the spin coating of resist, the exposure to the 7th mask, the development of resist, etching promoted with ion, and exfoliation of resist are needed.
[0284]Drawing 92: the metal layer 517 of the 2nd 1-micrometer level that consists of aluminum is vapor-deposited on the wafer 500. The 2nd level of contact is given by this metal layer 517. This is needed because the line density of your kind consideration is required for the heater 514, and it is because this wiring must be a low resistance metal. This layer gives thermal diffusion or a heat shunt, as some first examples described.
[0285]Drawing 93: the metal 517 of the 2nd level is etched using the 8th mask. In this process, the spin coating of resist, the exposure to the 8th mask, the development of resist, plasma etching, and exfoliation of resist are needed. This is the usual NMOS process. This insulated metallic disk on the heater 514 is a thermal diffusion object used in order to distribute waste heat and to avoid a heat spot.
[0286]Drawing 94: deposit the thick film glass layer 518 on the wafer 500. Sufficient thickness to give a suitable mechanical strength to resist the shock of a burst of a bubble is required for this layer 518. Since a field large enough is covered and heat is diffused so that ink may not boil when ink contacts glass, sufficient glass needs to accumulate. Although it is thought that a thickness of 4 micrometers is suitable, it is easily changeable if needed.
[0287]Drawing 95: in this process, etching performed until it goes down the heat oxide layer 504 and reaches the pouring field 503 using the mask of the 9th level of the cylindrical barrel 519 in the overcoat 518 is required. As for CVD glass and heat quartz, both sides are etched. In this process, the exposure to the spin coating of resist and the mask of the 9th level, the development of resist, etching promoted with anisotropy ion, and resist removing ** are required.
[0288]Drawing 96: the thermal action room 520 is highly formed selectively on SiO_2 using the anisotropy plasma etching of silicon. This is an essential thing when the SiO_2 protective layer which otherwise separates the heater 514 from tunic protection is etched. The barrel 519 etched beforehand achieves the duty as a mask of this process. In this case, 17-micrometer anisotropic etching is used. It must be careful so that the heat SiO_2 layer 504 may not be etched too much.
[0289]Drawing 97: the nozzle channel 512 is etched by anisotropy ion promotion etching from the opposite hand of the wafer 500. The channel 521 is about 60 micrometers in diameter.
It is about 500 micrometers in depth.
the depth of the channel 521 is nozzle length for which the distance between the crowning of a channel and the pars basilaris ossis occipitalis of the thermal action room 520 is needed -- it is set up like. Etching is performed via the resist 522.
[0290]Drawing 98: the passage of a nozzle is etched from the front face of the wafer 500 using high anisotropy ion promotion etching. This etching is to the crowning of the nozzle channel 521 by which back etching was carried out from the pars basilaris ossis occipitalis of the thermal action room 520, and is about 20 micrometers in length, and 20 micrometers in diameter. The nozzle barrel 523 is formed from these.
[0291]Drawing 99: the coat of the 0.5-micrometer passivation layer 524 which consists

of tantalum is uniformly carried out to the upper surface of the wafer 500 whole.
[0292]Drawing 100: at this process, a window can open for the connection pad 525. Here, resist coating, the exposure to the mask of the 12th level, the development of resist, etching of the tantalum passivation layer 524, etching promoted with the ion of the overcoat 518, and resist removing ** are required. When 2-micrometer aluminum can use for a pad region, it is easy to avoid etching via this pad formed with the metal 517 of the 2nd level.
[0293]Drawing 101: After the probe of the wafer 500, a ZBJ chip is built into a frame or an extrusion-molding base material as mentioned above, and paste it up there. The wire 526 is combined with the pad formed with the metal 525 of the 2nd level in the both ends of this chip. A supply rail is combined along with two long edge of this chip. Then, a connecting part is stopped into an epoxy resin.
[0294]Drawing 102: Here, the ZBJ nozzle of the front injection type filled with the ink 527 is shown. In this case, a drop will blow off caudad, if a nozzle discharges. Since this type of head cannot perform restoration of the ink by capillarity, it needs to introduce ink using positive pressure. Similar head structure can be used for the nozzle discharged to a counter direction by filling a head heated chip from the side else.
[0295]Although general suitable nozzle structure was explained above, and differences among some have the same process, it can use for the characteristic nozzle structure illustrated to drawing 14 thru/or drawing 19. Each of the following processes is the 2micromNMOS process of having metal of two levels. It is because this process is a high resolution and is the simplest process that can be used for manufacture of a color ZBJ device with high performance. Since consistency is among the following processes, the quicker comparison between each process is possible.
[0296]The outline of the process of a process required to acquire the structure shown in drawing 14 is as follows.
[0297]1) Start wafer :P A type and 600 micrometers in thickness;
2) Grow up the silicon nitride of 0.15 micrometer.
[0298]3) Pattern a nitride using the mask 1.
[0299]4) Pour in the field.
[0300]5) Grow up the field oxide of 0.8 micrometer.
[0301]6) Pour in arsenic using the mask 2.
[0302]7) Grow up the gate oxide of 0.1 micrometer.
[0303]8) Deposit polysilicon (1 micrometer).
[0304]9) Pattern polysilicon using the mask 3.
[0305]10) Etch diffusion windows.
[0306]11) Diffuse an n^+ field.
[0307]12) Deposit 1micromCVD glass.
[0308]13) Pattern a terminal area using the mask 4.
[0309]14) Deposit the boronizing hafnium heater of 0.05 micrometer.
[0310]15) Etch a heater using the mask 5.
[0311]16) Deposit the 1st metal (1 micrometer).
[0312]17) Pattern metal using the mask 6.
[0313]18) Deposit 1micromCVD glass.
[0314]19) Pattern a contact part using the mask 7.
[0315]20) Deposit the 2nd metal (a heat shunt is included) and 1 micrometer of

aluminum.
[0316]21) Pattern metal using the mask 8.
[0317]22) Deposit CVD glass of ten micrometers.
[0318]23) Etch a nozzle via CVD glass using the mask 9.
[0319]24) A thermal action room is etched using isotropic etching.
[0320]25) Carry out back etching of the barrel via a wafer using the mask 10.
[0321]26) Connect a thermal action room with a barrel using etching without the mask of anisotropy.
[0322]27) Deposit the tantalum passivation of 0.5 micrometer.
[0323]28) Open a pad using the mask 11.
[0324]29) Perform a wafer probe.
[0325]30) Include in a head assembly.
[0326]31) Connect a wire.
[0327]32) Carry out potting to an epoxy resin.
[0328]33) It is filled up with ink. A head is filled by capillarity.
[0329]The process outline of a process required to acquire the structure shown in drawing 15 is as follows.
[0330]1) Start wafer :P A type and 600 micrometers in thickness
[0331]2) Grow up the silicon nitride of 0.15 micrometer.
[0332]3) Pattern a nitride using the mask 1.
[0333]4) Pour in the field.
[0334]5) Grow up the field oxide of 0.8 micrometer.
[0335]6) Plant arsenic using the mask 2.
[0336]7) Grow up the gate oxide of 0.1 micrometer.
[0337]8) Deposit polysilicon (1 micrometer).
[0338]9) Pattern polysilicon using the mask 3.
[0339]10) Etch diffusion windows.
[0340]11) Diffuse an n^+ field.
[0341]12) Deposit CVD glass of one micrometer.
[0342]13) Pattern a contact part using the mask 4.
[0343]14) Deposit the HfB_2 heater of 0.05 micrometer.
[0344]15) Etch a heater using the mask 5.
[0345]16) Deposit the 1st metal (1 micrometer).
[0346]17) Pattern metal using the mask 6.
[0347]18) Deposit 1micromCVD glass.
[0348]19) Pattern contact using the mask 7.
[0349]20) Deposit the 2nd metal (a heat shunt is included) and 1 micrometer of aluminum.
[0350]21) Pattern metal using the mask 8.
[0351]22) Deposit 3micromCVD glass.
[0352]23) Etch the entrance to a thermal action room via CVD glass using the mask 9.
[0353]24) -- isotropic plasma -- therefore, a thermal action room is etched dirtily.
[0354]25) Etch a hole into the 520-micrometer depth and 80-micrometer width from the rear face of a wafer using the mask 10.
[0355]26) Connect a thermal action room with a barrel by anisotropy RIE, using a thermal action room entrance as a mask.

[0356]27) Deposit 0.5micrometer tantalum passivation.
[0357]28) Open a pad using the mask 11.
[0358]29) Perform a wafer probe.
[0359]30) Carry out bonding of the wire.
[0360]31) Carry out potting to an epoxy resin.
[0361]32) Include in a head assembly.
[0362]33) Fill up a head assembly with ink.
[0363]34) Apply the right ink pressure more than the bubble pressure of a nozzle to a head.
[0364]The outline of the process of a process required to acquire the structure shown in drawing 16 is as follows.
[0365]1) Start wafer :P A type and with a 600-micrometer [2] thickness [0.15-micrometer] silicon nitride are grown up.
[0366]3) Pattern a nitride using the mask 1.
[0367]4) Pour in the field.
[0368]5) Use the mask 2 and etch an annular slot 22 micrometers in diameter, a depth of 2 micrometers, and 1 micrometer in width into the surroundings of a nozzle location.
[0369]6) Grow up the field oxide of 0.4 micrometer (this grows also on the wall of a slot).
[0370]7) Deposit a 0.05micromHfB_2 heater.
[0371]8) Etch a heater using the mask 3.
[0372]9) Pour in arsenic using the mask 4.
[0373]10) Grow up gate oxide of 0.1 micrometer.
[0374]11) Grow up polysilicon (1 micrometer).
[0375]12) Pattern polysilicon using the mask 5.
[0376]13) Etch diffusion windows.
[0377]14) Diffuse an n^+ field.
[0378]15) Deposit 1micromCVD glass.
[0379]16) Pattern contact using the mask 6.
[0380]17) Deposit the 1st metal (1 micrometer).
[0381]18) Pattern metal using the mask 7.
[0382]19) Deposit 1micromCVD glass.
[0383]20) Pattern contact using the mask 8.
[0384]21) Deposit the 2nd metal and 1-micrometer aluminum.
[0385]22) Pattern metal using the mask 9.
[0386]23) Deposit 20micromCVD glass and form a nozzle layer.
[0387]24) Carry out anisotropic etching of a thermal action room and the nozzle using the mask 10 (smaller diameter of 18 micrometers or less).
[0388]25) Etch a hole into the 520-micrometer depth and 80-micrometer width from the rear face of a wafer using the mask 11, and combine with a nozzle.
[0389]26) Extend a thermal action room to the end of a heater slot using isotropic "wash" etching with special silicon.
[0390]27) Deposit 0.5micrometer tantalum passivation.
[0391]28) Open a pad using the mask 12.
[0392]29) Perform a wafer probe.
[0393]30) Carry out bonding of the wire.

[0394]31) Carry out potting to an epoxy resin.
[0395]32) Include in a head assembly.
[0396]33) Fill up a head assembly with ink.
[0397]The outline of the process of a process required to acquire the structure shown in drawing 17 is as follows.
[0398]1) Start wafer :P A type and 600 micrometers in thickness
[0399]2) 0.15micrometer silicon nitride deposition.
[0400]3) Pattern a nitride using the mask 1.
[0401]4) Pour in the field.
[0402]5) Etch a circular sulcus 22 micrometers in diameter, a depth of 2 micrometers, and 1 micrometer in width into the surroundings of a nozzle location using the mask 2.
[0403]6) Grow up 0.4micrometer field oxide (this grows also on the wall of a slot).
[0404]7) Deposit a 0.05micromHfB_2 heater.
[0405]8) Etch a heater using the mask 3.
[0406]9) Pour in arsenic using the mask 4.
[0407]10) Grow up 0.1micrometer gate oxide.
[0408]11) Deposit polysilicon (1 micrometer).
[0409]12) Pattern polysilicon using the mask 5.
[0410]13) Etch diffusion windows.
[0411]14) Diffuse an n^+ field.
[0412]15) Deposit 1micromCVD glass.
[0413]16) Pattern contact using the mask 6.
[0414]17) Deposit the 1st metal (1 micrometer).
[0415]18) Pattern metal using the mask 7.
[0416]19) Deposit 1micromCVD glass.
[0417]20) Pattern contact using the mask 8.
[0418]21) Deposit the 2nd metal (a thermal diffusion way is included) and 1-micrometer aluminum.
[0419]22) Pattern metal using the mask 9.
[0420]23) Deposit 3micromCVD glass.
[0421]24) Carry out anisotropic etching of a thermal action room and the nozzle using the mask 10 (in order to prevent etching of a heater, a diameter is made small with 18 micrometers or less).
[0422]25) Etch a hole into a depth of 520 micrometers, and 80 micrometers in width from the rear face of a wafer using the mask 11.
[0423]26) Extend a thermal action room to the end of a heater slot using isotropic "wash" etching with special silicon.
[0424]27) Deposit 0.5micrometer tantalum passivation.
[0425]28) Open a pad using the mask 12.
[0426]29) Perform a wafer probe.
[0427]30) Carry out bonding of the wire.
[0428]31) Carry out potting to an epoxy resin.
[0429]32) Carry in a head assembly.
[0430]33) Fill up a head assembly with ink.
[0431]The outline of the process of a process required to acquire the structure shown in drawing 18 is as follows.

[0432]1) Start wafer :P A type and 600 micrometers in thickness
[0433]2) Grow up 0.15micrometer silicon nitride.
[0434]3) Pattern a nitride using the mask 1.
[0435]4) Pour in the field.
[0436]5) Grow up 0.7micrometer field oxide.
[0437]6) Pour in arsenic using the mask 2.
[0438]7) Grow up 0.1micrometer gate oxide.
[0439]8) Deposit polysilicon (1 micrometer).
[0440]9) Pattern polysilicon using the mask 3.
[0441]10) Etch diffusion windows.
[0442]11) Diffuse an n^+ field.
[0443]12) Etch the annular crevice of the slightly wide 2-micrometer depth from the diameter of a nozzle using the mask 4.
[0444]13) Deposit 1micromCVD glass.
[0445]14) Pattern contact using the mask 5.
[0446]15) Deposit a 0.05micromHfB_2 heater.
[0447]16) Carry out anisotropic (perpendicular chisel) etching of the heater using the mask 6.
[0448]17) Deposit the 1st metal (1 micrometer).
[0449]18) Pattern metal using the mask 7.
[0450]19) Deposit 1micromCVD glass. This forms an inter level dielectric for a heater with a wrap.
[0451]20) Pattern contact using the mask 8.
[0452]21) Deposit the 2nd metal (a thermal diffusion way is included) and 1 micrometer of aluminum.
[0453]22) Pattern metal using the mask 9.
[0454]23) Deposit 20micromCVD glass.
[0455]24) Etch a nozzle anisotropically into CVD glass using the mask 10.
[0456]25) Etch the thermal action room of silicon by ion reed SUTEDDO plasma etching peculiar to silicon, using a CVD glass nozzle as a mask.
[0457]26) Etch a hole into the 520-micrometer depth and 80-micrometer width from the rear face of a wafer, and connect with a thermal action room.
[0458]27) Deposit 0.5micrometer tantalum passivation.
[0459]28) Open a pad using the mask 12.
[0460]29) Perform a wafer probe.
[0461]30) Carry out bonding of the wire.
[0462]31) Carry out potting to an epoxy resin.
[0463]32) Carry in a head assembly.
[0464]33) Fill up a head assembly with ink.
[0465]The outline of the process of the process for acquiring the structure shown in drawing 19 is as follows.
[0466]1) Start wafer :P A type and 600 micrometers in thickness
[0467]2) Grow up 0.15micrometer silicon nitride.
[0468]3) Pattern a nitride using the mask 1.
[0469]4) Pour in the field.
[0470]5) Grow up 0.7micrometer field oxide.

[0471]6) Pour in arsenic using the mask 2.
[0472]7) Grow up 0.1micrometer gate oxide.
[0473]8) Deposit polysilicon (1 micrometer).
[0474]9) Pattern polysilicon using the mask 3.
[0475]10) Etch diffusion windows.
[0476]11) Diffuse an n^+ field.
[0477]12) Etch the annular crevice of the slightly wide 2-micrometer depth from a nozzle diameter using the mask 4.
[0478]13) Deposit 1micromCVD glass.
[0479]14) Pattern contact using the mask 5.
[0480]15) Deposit a 0.05micromHfB_2 heater.
[0481]16) Etch a heater anisotropically using the mask 6 (to perpendicular direction).
[0482]17) Deposit the 1st metal (1 micrometer).
[0483]18) Pattern metal using the mask 7.
[0484]19) Deposit 1micromCVD glass. This forms an inter level dielectric for a heater with a wrap.
[0485]20) Pattern contact using the mask 8.
[0486]21) Deposit the 2nd metal (a thermal diffusion way is included) and 1 micrometer of aluminum.
[0487]22) Pattern metal using the mask 9.
[0488]23) Deposit 3micromCVD glass.
[0489]24) Etch a thermal action room anisotropically into CVD glass using the mask 10.
[0490]25) Etch a silicon nozzle anisotropically by using a CVD glass hole as a mask using ion reed SUTEDDO etching peculiar to silicon.
[0491]26) Using the mask 11, etch a hole into the 520-micrometer depth and 80-micrometer width from the rear face of a wafer, and connect with a nozzle.
[0492]27) Deposit 0.5micrometer tantalum passivation.
[0493]28) Open a pad using the mask 12.
[0494]29) Perform a wafer probe.
[0495]30) Carry out bonding of the wire.
[0496]31) Carry out potting to an epoxy resin.
[0497]32) Carry in a head assembly.
[0498]33) Fill up a head assembly with ink.
[0499]The ZBJ recording head 200 can apply various record methods with the ZBJ chip 100. For example, it is applicable to the method of recording by the print head of the method of crossing and printing a page with the scanning head used well conventionally, or overall width and a cover half. Drawing 103 thru/or Drawing 107 show the various examples using various ZBJ heads.
[0500]Drawing 103 has the scanner 541 which shows the color copying machine 531 and reads the manuscript which should be copied. The scanner 541 outputs the data of red, green, and blue (RGB) to the signal processor 543. Then, RGB data are changed into the data of the cyanogen for every dot suitable for printing with the device 100, magenta, yellow, and black (CMYK). CMYK data are inputted into the data formatter 545. This data formatter 545 operates by the circuit of a statement to drawing 45 and drawing 46. The data formatter 545 outputs data to the full color ZBJ head 550. Record of 400 pixels per inch is possible for the full color ZBJ head 550 to the page of A3 conveyed by the

paper conveyer style 547. The microcomputer 549 for control generalizes operation of the copying machine 531 whole by controlling the sequence of the scanner 541, the signal processor 543, and the paper conveyer style 547.
[0501]Drawing 104 shows the color facsimile 533. Here, identical codes are given to the same component as Drawing 103. The scanner 541 scans and reads a manuscript. The read image data is compressed by the data compression machine (compressor) 560, and is transmitted after that. The data compression machine 560 can use all the standard data compression systems (system), such as a JPEG standard. This data compression machine 560 is outputted to the modem 562 by which the data to transmit was connected to PSTN or ISDN network 564. Modem (MODEM)562 receives data and outputs it to the image data double sign-ized expandor (image expander) 566. The double sign-ized expandor 566 compensates the function of the data compression machine 560. The double sign-ized expandor 566 outputs received data to the data formatter 545 as mentioned above. In the example of this figure, the color ZBJ head 551 which has width longer than the width of the paper used for record is used.
[0502]Drawing 105 shows the printer 535 for computers. This printer can perform the print of a color or monochrome with the type of the ZBJ head to be used. Data is inputted into the data receiving section 568 via the input part 569. The microcontroller 549 stores the received data in the image memory 571. The image memory 571 outputs data to the full color data formatter 545 or a monochrome data formatter as mentioned above. In this example, the data formatter 545 outputs data to an overall-width ZBJ head, and the print to the paper conveyed by the paper conveyer style 547 is performed.
[0503]Drawing 106 shows the example in the video printer 537. This video printer 537 receives a video data via the input part 574. This input part 574 is connected to the television picture decoder and the unit 573 which has ADC. This unit 573 outputs the picture element data of a picture to the frame storage parts store 575. The signal processor 543 changes RGB data into the CMYK data for a print like the above. In this example, the small color ZBJ head 553 prints on the paper of photograph size conveyed by the paper conveyer style 547.
[0504]Finally, Drawing 107 shows the simple printer 539 with which formatting of a page is performed by the host computer 577. The host computer 577 outputs image data and control information to the buffer 579. The information on this buffer is outputted to the data formatter 545 like the above. The control logic unit 581 also receives the command from the host computer 577, and controls the paper conveyer style 547 by this command.
[0505]Furthermore, the person skilled in the art can understand that any combination of a ZBJ head is applicable to the above-mentioned example.
[0506]For example, the above-mentioned multi head redundant configuration can be used for a page printer type head and a scanning head. For the print of super high density (for example, 1600dpi), the method of monochrome record is applicable in said all examples.
[0507]The above example is only an example of this invention, and it is obvious for a person skilled in the art to add change, without deviating from the range of this invention.
[0508]
[Table 1]

ＺＢＪの応用例

応用例／特徴	1.走査型 連続階調 (contone) カラー ZBJﾍｯﾄﾞ	2.走査型 グレー階調 ZBJﾍｯﾄﾞ	3.写真サイズ 連続階調 カラー ZBJﾍｯﾄﾞ	4.全幅 A4連続階調 カラー ZBJﾍｯﾄﾞ
ﾁｯﾌﾟｻｲｽﾞ(mm)	10×4	10×1.5	100×2	220×4
ﾉｽﾞﾙ 数	2048	512	5120	51200
画素数	128	128	1280	3200
ﾉｽﾞﾙ/画素/ｶﾗｰ	4	4	1	4
要素とする色の数	4	1	4	4
ﾌﾟﾘﾝﾄ速度	3分 (A4)	3分 (A4)	8秒 (写真ｻｲｽﾞ)	3.7秒 (A4)
階　調	フルグレースケール			
解像度 (画素/ｲﾝﾁ)	400	400	400	400

[0509]
[Table 2]

ＺＢＪの応用例（表１の続き）

応用例／特徴	5.全幅 A4 2ﾚﾍﾞﾙ ZBJﾍｯﾄﾞ	6.高速度 A3連続階調 ｶﾗｰZBJﾍｯﾄﾞ	7.中速度 A3連続階調 ｶﾗｰZBJﾍｯﾄﾞ
ﾁｯﾌﾟｻｲｽﾞ(mm)	220×2	310×4	310×2
ﾉｽﾞﾙ 数	12800	71680	17920
画素数	12800	4480	4480
ﾉｽﾞﾙ/画素/ｶﾗｰ	1	4	1
要素とする色の数	1	4	4
ﾌﾟﾘﾝﾄ速度	3.7秒 (A4)	5.3秒 (A3)	21秒 (A3)
階　調	フルグレースケール		
解像度 (画素数/ｲﾝﾁ)	1600	400	400

[0510]
[Table 3]

故　障	結　果
主駆動トラック断線	主ヒータ故障，冗長ヒータが肩代わりする。
冗長駆動トラック断線	冗長ヒータ故障，影響無し。
V+トラック断線	32ヒータのブロック故障， 冗長ヒータが肩代わりする。
グランド接続断線	冗長32ヒータのブロック故障，影響無し。
２つの主駆動トラック短絡	両ノズル吐出する。
２つの冗長駆動トラック短絡	影響無し。
主駆動トラックの冗長 駆動トラックへの短絡	両ヒータが直列にV+とグランドに挿入され、 常時、出力1/2 となる。 主ヒータか冗長ヒータが過熱し、断線する （通常、平均電力はパルス電力の1/32）。 他のヒータが肩代わりする。
主駆動トラックがV+へ短絡	動作開始すると駆動トランジスタが溶融 する。冗長回路が肩代わり。
主駆動回路がグランドへ短絡	主ヒータが常時ONとなっているので、過熱 し、断線する。冗長回路が肩代わりする。
冗長駆動トラックがV+へ短絡	冗長ヒータが常時ONとなっているので、過熱 し、断線する。影響無し。
冗長駆動トラックがグランド へ短絡	冗長トランジスタは動作開始すると溶融す る。主回路が動作すれば、影響無し。
V+がグランドへ短絡	V+トラックかグランドトラックが溶融。 V+トラックが溶融すると、冗長回路が分離さ れた主回路を肩代わりする。 そのほかの状態は影響無し。
検出トラック断線	冗長回路が動作しない。影響無し。
検出トラックのその他の状態	主駆動回路と同様。